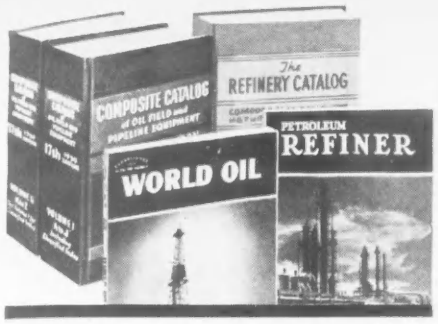

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for the refining-natural gasoline industry

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CONTENTS

January, 1952 **Vol. 134, No. 1**

CURRENT OUTLOOK SECTION

Looking Ahead ... 19
Publisher's Page — *Ray L. Dudley* ... 21
The Changing Panorama ... 23
Report from the Observatory — *Ray L. Dudley and Warren L. Baker* ... 24
Petroleum Trends — *Cecil W. Smith* ... 26
Share-the-Shortage Is Philosophy of Despair — *Robert G. Dunlop* ... 29
Monthly News Analysis ... 31
The Month's Completions ... 34
What's Ahead in '52? — *L. F. McCollum, Col. Harry T. Klein, T. S. Petersen, S. A. Swensrud and K. S. Adams* ... 39
Steel to Continue Scarce in Second Quarter — *Robert E. Spann* ... 41
Need for New Oil Reserves Poses Exploration Challenge — *Dr. B. B. Weatherby* ... 45
Higher Crude Output Required in 1952 ... 48
Water-Flooding Trend Shown in Mines Bureau Report ... 51

NEW EQUIPMENT SECTION

For More Information on Products Advertised ... 54
Reader Service Postcards ... 55
New Catalogs and Equipment Literature ... 55
New and Improved Equipment Supplementing Composite Catalog ... 57
Other New and Improved Equipment ... 59
New Catalogs and Equipment Literature in Advertisements ... 64

EXPLORATION SECTION

Geology of the Elk City Field — *Richard J. Beams* ... 67
The Space-Time Concept in Subsurface Geology — *Dr. L. W. Leroy* ... 74
Storage of Well Cores at Texas Research Center Proposed — *Fred D. Thompson* ... 78
Air Service Speeds Well Cores — *James E. Campbell* ... 82
Exploration 22.3 Percent Ahead of 1950 Period ... 86
U. S. Oil, Distillate and Gas Discoveries and Extensions in November ... 88

DRILLING SECTION

Power Rig Features Departure from Design Standards — *W. B. Colvin* ... 101
WORLD OIL Graphics: Lube Oil Care ... 106
Field Use Proves Tripod Rig — *H. W. Slater* ... 108
Shop Area Lighting ... 112
Hole Straightening Methods — *Gordon Jackson* ... 113
Slush Pump History and Possible Developments — *Roy E. Edwards* ... 118
Lost Circulation—Causes and Remedies — *H. J. Shumate* ... 128
New Products Reduce Problem of Lost Returns ... 132
Appraisal of Drilling Mud Costs (Last of Two Parts) — *Victor V. Horner* ... 137
How to Do It—Drilling Hints ... 142

PRODUCTION SECTION

Fluid Separation with Permeable Plastics — *C. B. Jahn and Donald M. Taylor* ... 155
Flooding Revives Oklahoma Pool — *Anthony Gibbon* ... 160
Unique System Speeds LPG Fuel Tank Exchange — *Gilbert M. Wilson* ... 164
Electric Dehydration of Heavy Crudes — *Robert L. Pettefer* ... 168
Effects of Gas Injection in Low Gravity Oil Pool — *Ray Staples* ... 174
The Sucker Rod Pumping System — *Kenneth N. Mills* ... 182
Wellheads Raised When Reservoir Planned ... 192
How to Do It—Production Hints ... 194

PIPE LINE SECTION

Simplified Gas Pipe Line Calculations — *J. T. Hull* ... 207
Cathodic Protection of Tank Bottoms ... 212
Model Aids Station Personnel ... 213
Ditching with Explosives — *William G. Piper* ... 214
Effect of Transient Pressures on Flow Metering — *E. C. Fitch, Jr., and Harry M. Wyatt* ... 218
Pipe Line Construction — *Cecil W. Smith* ... 223
How to Do It—Pipe Line Hints ... 226

INTERNATIONAL SECTION

Cretaceous Oil Discoveries in Central Alberta — *C. Warren Hunt* ... 233
Kingdoms of Oil: Kuwait (Tenth of a Series) — *Frank D. Potter* ... 238
Iran Still Awaits Oil Grab Benefits ... 242
Egypt—The Next Iran? — *Robert E. Spann* ... 246
Pakistan Test Drilling ... 250
Edmonton-Vancouver Line Approved ... 251

DEPARTMENTS

The Oil Man's Calendar ... 32
Men in the Industry News ... 256
Associations ... 267
Equipment and Service Suppliers' Notes ... 270
Squeaks from the Bullwheel ... 280

ADVERTISERS' INDEX

*Asterisk preceding name of advertiser indicates that detailed data on products and services of the firm will be found in current 18th (1951) edition of The Composite Catalog of Oil Field and Pipe Line Equipment.

A

Abrams Aerial Survey 277
*Acme Fishing Tool Co. 270
Acme Foundry & Machine Co. 150
Aero Service Corp. 247
*Aetna Ball and Roller Bearing Co. 94
Affiliated National Hotels 228
*Ajax Iron Works 179
*Altens Foundry & Machine Works, Inc. 180
*American Iron & Machine Works Co. 111
*American Manufacturing Co. of Texas 15
*American Sand-Banum Co., Inc. 196
*Axelson Manufacturing Co. 159

B

*Baash-Ross Tool Co. 73
*Baker Oil Tools, Inc. ..... 22 and 244-245
*Baroid Sales Division National Lead Co. 232
Wm. M. Barret, Inc. 268
*Beaumont Iron Works Co. 77
*Beaver Pipe Tools, Inc. 227
*Bethlehem Steel Co. ..... 28 and 119
*Bethlehem Supply Co. 149
*Black, Sivalls & Bryson, Inc. 167
*S. R. Bowen Co. 253
*The Brewster Co. 75
*Byron Jackson Co. ..... I Cover

C

Cable & Staples 258
*Cameron Iron Works, Inc. ..... II Cover and 206
*Cardwell Manufacturing Co. 42-43
Caterpillar Tractor Co. 217
*The Cavins Co. 253
*Chicago Pneumatic Tool Co. 263
*Christensen Diamond Products Co. 144
Continental Supply Co. 133-134-135-136
*Fred E. Cooper, Inc. 249
*The Cooper-Bessemer Corp. 219
Core Laboratories, Inc. 66
*Crane Co. 11
W. H. Curtin & Co. 272

D

Darling Valve & Mfg. Co. 193
Diamond Chain Company, Inc. 115
Dowell Incorporated 20
Dresser Industries, Inc. 259
*Drilling & Service, Inc. 129

E

The Eagle-Picher Co. 189
*Eastman Oil Well Survey Co. 141
E. H. Edwards Co. 143

F

The First National Bank and Trust Co. 275
*Fluid Packed Pump Co. 187-188
*Foster Cathead Co. 92

G

*Gaso Pump & Burner Manufacturing Co. 205
The Geolograph Co. 147
The B. F. Goodrich Co. 9
*H. P. Gott Manufacturing Co. 276
*Grove Regulator Co. 255
*The Guiberson Corp. 183

H

*Halliburton Oil Well Cementing Co. ..... 30, 65 and 89
*Harbison-Fischer Manufacturing Co. 274
*Harrisburg Steel Corp. 264
Harrison Equipment Co., Inc. 85
*Hercules Tool Co. 284
Hinderliter Tool Company Division H. K. Porter Co. 283
Houston Contracting Co. 224
Houston Laboratories 268
*Houston Ready-Cut House Co. 200
*Hughes Tool Co. ..... 231 and IV Cover
*Hutchison Manufacturing Co. 148

I

*International Harvester Co. 71
The International Nickel Co. ..... 10 and 169

J

*Jefferson Union Co. 280
*Jensen Brothers Manufacturing Co. 204
*M. O. Johnston Oil Field Service Corp. 285
Johnston Oil Field Service Corp. 265
Jones & Laughlin Supply Co. 81
*Justrite Manufacturing Co. 202

K

Kaiser Steel Corp. 225
Kelley Manufacturing Co. 272
*Kerotest Manufacturing Co. 200
*King Oil Tools 253
*Kinzbach Tool Company, Inc. 97

L

*L & M Machine Works 150
*Lamtex Equipment Corp. 284
*Lane-Wells Co. ..... 47, 177, 237, 282, and III Cover
*Larkin Packer Co. 266
*The Thomas Laughlin Co. 203
*The Layne and Bowler Co. 165
*LeBus Rotary Tool Works, Inc. 87
Levingston Shipbuilding Co. 90
*Link-Belt Co. 3
*Lone Star Tool Co. 146
*Lufkin Foundry & Machine Co. 153

M

Macwhyte Company 5
*Magnet Cove Barium Corp. 259
Jas. P. Marsh Corp. 12
*John N. Martin, Mfr. 147
The Mayo Hotel 230
*McCullough Tool Co. 281
*Mid-Continent Supply Co. 282
*Mission Manufacturing Co. 99
*Lee C. Moore Corp. 127

N

National Bank of Tulsa 14
National Lead Co. 232
*The National Supply Co. 35-36-37-38
*National Tank Co. 161
National Trust Company Limited 254
National Tube Co. 210-211
*Nordstrom Valve Division Rockwell Manufacturing Co. 52- 53
*W. C. Norris, Manufacturer, Inc. 25

O

*Walter O'Bannon Co. 280
*Oil Center Tool Co. 197
*Oil Well Manufacturing Corp. 279
*Oil Well Supply Co. 4
Orange Roller Bearing Co. 13
*Otis Pressure Control, Inc. 185

P

Pacific Coast Borax Co. 198
*Page Oil Tools, Inc. 190
*Parkersburg Machine Co. 268
*The Parkersburg Rig & Reel Co. 191
*Pelican Well Tool & Supply Co. 268
*The Pelton Water Wheel Co. 173
*Perforating Guns Atlas Corp. 138-139
Petroleum Distributing Co. 258
Petroleum Electric Power Assoc. 257
*Petroleum Specialty Co. 273
Pittsburgh Coke & Chemical Co. 221
H. K. Porter Co. ..... 195 and 283

R

*Rector Well Equipment Co. 171
*Reed Roller Bit Co. ..... 17 and 131
*Republic Steel Corp. 61
*The Ridge Tool Co. 269
*Rockwell Manufacturing Co. ..... 33 and 52- 53
*Rollway Bearing Co. 8
*Rolo Manufacturing Co. 262
The Royal Bank of Canada 251

S

*S & R Tool & Supply Co. 147
*Schlumberger Well Surveying Corp. 154
Seismograph Service Corp. 69
*Shaffer Tool Works 95
Sheffield Steel Corp. 91
A. O. Smith Corp. 222
Southern Engine & Pump Co. 202
*Southern Mill & Manufacturing Co. 175
South Texas National Bank 184
*Standco Brake Lining Co. ..... 147 and 268
*Stewart & Stevenson Services, Inc. 6
Superior Iron Works & Supply Co. 125

T

*Templeton, Kenly & Co. 150
Texas Electric Steel Casting Co. 163
Texas Employers Insurance Assoc. 93
*Texas Flange Co. 98
*The Thermoid Co. 145
*Thompson Tool Co. 152
*Thornhill-Craver Co. 117
The Torrington Co. 79
Trading Post 278
*Tretolite Co. 181
Trojan Construction Co. 230
*Tube-Kote, Inc. 229
*Tuboscope Co. 199

U

*Union Wire Rope Corp. 96
*Unit Rig & Equipment Co. 241
United Geophysical Co. 123
United States Steel Corp. ..... 4, 18 and 210-211
United States Steel Export Co. 210-211
*Universal Atlas Cement Co. 18

V

Varner Co. 252
*Victaulic Company of America 16
*Visco Products Co. 7
J. H. H. Voss Co. 260

W

*W-K-M Company, Inc. 261
*Walker-Neer Machine Co. 83
*Waukesha Motor Co. 286
Waukesha Sales & Service Co. 121
Welex Jet Services, Inc. 107
*Well Equipment Manufacturing Corp. 151
Wichita Tool Repair Co. 150
*Wilson Foundry & Machine Co. 201
*Wilson Manufacturing Co. 105
World Oil 271
*Worthington Pump & Machinery Corp. 63

Y

*Yale Machine Works 227
The Youngstown Sheet & Tube Co. 100

Looking Ahead

U. S. WILL NEED 12 to 14 million barrels of oil per day by 1975, about double present requirements, predicted Texas Railroad Commissioner Ernest O. Thompson. These demands in next quarter century will be met, he foresees, by new discoveries, better recovery methods, secondary recovery from older fields, increased use of butanes and propanes, conversion of natural gas into gasoline, and petroleum imports.

U. S. OPERABLE CRUDE OIL REFINING CAPACITY will rise to 7,365,000 barrels daily by end of September, 1952, from the 7,228,000 barrels at end of 1951, American Petroleum Institute survey indicates.

WAGE INCREASE OF 25 CENTS PER HOUR will be goal of Oil Workers International Union in negotiations with oil companies throughout country in January and February. This contrasts with raise of only about 7 cents permissible without prior Wage Stabilization Board approval under cost of living formula. Cost of living increase since January, 1951, would permit wage boost under that formula of 3.4 percent or about 7 cents per hour on $2 per hour wage. Such an increase has been accepted by some independent unions but rejected by others.

OIL AND GAS INDUSTRIES during 1952 will encounter the most critical period in procurement of Class B products, such as compressors, turbines, and heat exchangers, controlled by National Production Authority. Controlled materials in general are expected to come into better supply by third quarter of 1952, but scarcity of B products may not be relieved until late in fourth quarter or even the early part of 1953.

OIL COMPANIES, like other firms, henceforth may not have sufficient funds, after paying increased taxes, to finance new facilities. New corporate tax rates of 1951 total almost 70 percent over-all in some instances, giving federal treasury lion's share of earnings. Some large corporations are arranging for future borrowing from insurance companies and other lenders. Smaller companies and individuals, including oil producers, may be expected to require loans, similarly, and their troubles in holding on to their profits probably will make borrowing more difficult.

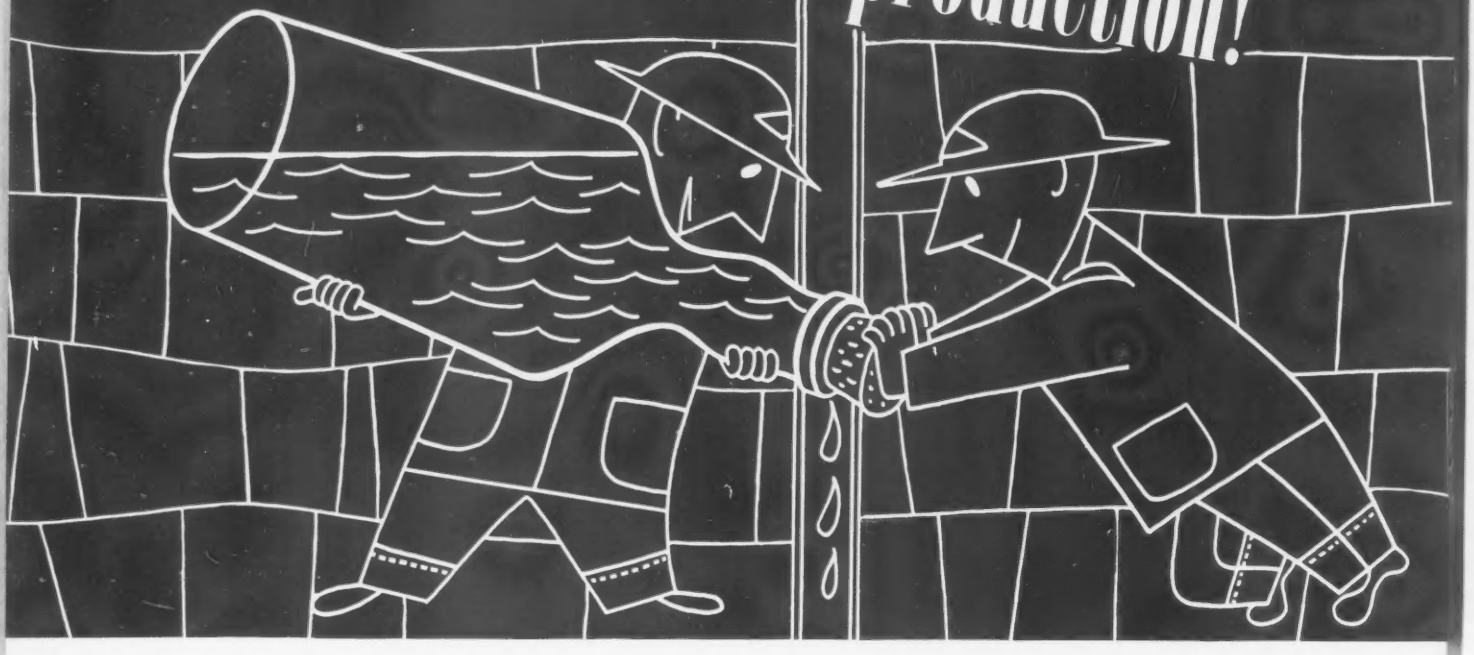
BY END OF 1952, Western Europe is expected to have enough refinery capacity to meet its needs, provided adequate crude is available. This will reduce European demand for U. S. refined products and boost receipts of crude from Middle East and possibly Venezuela.

SINCE ENORMOUS HORSEPOWER goes unused in expansion of gas from high pressures down to line pressures, utilization of this wasted power is being studied. In the near future, high pressure turbines likely will be driven by this gas.

LARGE MARKET for chemical weed killers made by oil and chemical companies is offered in cotton growing. These weed killers eliminate costly hand hoeing and promise farmers large savings. Similar chemical weed killers are proving successful also in raising various other crops.

UPWARD MOVEMENT OF NATURAL GAS PRICES in 1952 is indicated. Rates to industrial consumers, which are unregulated, will be raised, especially in Southwest, where they are very low. Numerous major transmission companies, wholesaling gas to distributing utilities, have applied to regulatory bodies for higher rates. If granted, higher wholesale rates would call for higher retail rates to consumers. Gas prices have remained unchanged and relatively cheap in recent years of inflation, as attested by insatiable demand for gas, and the industry's earnings have suffered.

PLUGGING for more production!



WATER SHUT OFF to Increase Oil Production by Dowell Plastic Service

Water entry into an oil well can reduce production, increase lifting costs and waste reservoir energy.

A new well made considerable water on completion. Water Location Surveys made with the Dowell Electric Pilot revealed the point of water entry to be a top section close to the casing seat. Dowell engineers used plastic to shut off this water. First, gravel was dumped on bottom and capped with plastic to protect the lower producing section. After the cap had set, additional plastic was squeezed in the section between the cap and the casing seat. Following this, the plug was drilled through and the bottom section of the well was shot. Results were excellent . . . production was 240 BOPD *with no water*.

Many workover and recompletion jobs have been successful as a result of Dowell Plastic Service. Experienced Dowell engineers spot the plastic in the right place us specially designed bailers or tubing squeeze techniq The plastic enters the well as a fluid . . . hardening an impervious solid after a predetermined time. Do Plastics penetrate the formation producing a posit bond and providing a permanent plug against encroach fluids. Dowell Plastic Service has also been used to g effect in correcting high gas-oil ratios, in setting li and in consolidating loose sands.

Ask your local Dowell station or office for comp information on the many uses of Dowell Plastic Ser in your well workover and completion programs.

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TULSA 1, OKLAHOMA
Subsidiary of The Dow Chemical Company

DOWELL

PLASTIC SERVICE

Ask your nearest Dowell Station for complete information on these Dowell services and products: Acidizing Service, Electric Pilot Services, Plastic Service, Chemical Scale Removal Service for heat exchange equipment, Jelflake, Paraffin Solvents, Magnesium Anodes for Corrosion Control, and Bulk Inhibited Hydrochloric Acid.

"First in Acidizing . . . since 1932"

Look to DOWELL

FOR OIL INDUSTRY CHEMICAL SER

HAND IN HAND

COLONEL JACK BERLIN, head of the Production department of Standard-Vacuum Oil Company, who fought the jungles of Indonesia, wrestled manfully with Mother Nature in the development of Indonesia's oil resources, and then equally as valiantly fought the Japanese invaders tooth, toenail and with aerial bomb, was talking. The place was Chicago; the time a noon hour during the 1951 American Petroleum Institute meeting; the audience, oil equipment men from all over the U. S.—members of the organization known as Nomads.

Colonel Jack didn't read a prepared speech. If he used notes, we didn't see them; but he was laying it down the groove in a manner which warmed the cockles of the heart of his audience.

He was talking about a feature which is almost unique to the oil business—the close relationship between oil men and those men in the associated industry which furnishes equipment and services.

We wish we could quote his exact words, just as we heard them, but it didn't occur to us until the speaker had finished that here was something for the entire industry to hear or read.

In substance, Colonel Jack gave just about as much credit to the manufacturers of oil tools and the performers of services to the oil industry as he did to the oil men for using those tools and services to develop the oil industry.

And we couldn't help but agree as to how right he was, because we have been privileged now for 35 years to watch and report the growth of the oil industry. In the forefront of exploration we have seen the manufacturing and service companies develop geophysical and allied services without which our oil supply would be pitifully small.

We have seen drilling move from an all-out "turnkey job" of 3500 feet of hole before the 1920's to the present depths, and we have seen the new depths preceded by improved metallurgy, by weight indicators, by internal combustion-driven rigs, etc. In 1921 an oil man who later became head of the world's largest oil company told the writer: "Internal combustion power can never be used for drilling because it is not elastic enough." But the manufacturers developed a hookup that was amply elastic. We've seen during those 35 years such an improvement of bits as we did not dream could be done. Even the derricks themselves have been transformed by new material, new strength and greater height. Drawworks are not simply bigger or heavier, they have had constructed into them the ingenuity of engineers who attended the same schools as the oil company engineers—with just as fine scholastic records. We've seen casing setting, cementing, completion practices revolutionized in 35 years by the manufacturers and service companies working with oil men. We've seen blowout preventers and special muds developed to the point where pressures are controlled today, while the "wild well," with far less than today's pressure, was an every week performance a third of a century ago.

Electric logging and improved coring instruments now detect sands missed in the old days.

A pumping unit of today is a far cry from the walking beam of 25 years ago. The sucker rods have had built into them the stamina to withstand the grueling test of thousands of feet of lift instead of hundreds. Gas lift, hydraulic lifts reach to depths formerly unthought of.

• • •

AS WE THINK of what has happened, our pen rushes so as not to leave out some of the multitude of things which space itself denies, though we know full well that even the cataloging of modern oil tools and services requires thousands of pages.

Distribution of equipment and supplies throughout the U. S. and sales and service men throughout the world—these have come to be accepted as a commonplace part of the oil industry. (Around 1000 supply stores dot the oil fields in the U. S. alone.) Twenty-four hour service is an accepted fact in the oil business, though this is not true of almost every other industry.

But to us who have seen this happen—who have seen oil men go into the most inaccessible sections of this country and the rest of the world, followed immediately by the service or the equipment man—the finest part of the whole thing has been the spirit of camaraderie and friendship between seller and user.

True there have been some heels on the one side and some snobs on the other, but by and large there is a friendly relationship between the man who sells and the man who uses which has definitely sustained a high calibre of man on the side of those who sell—and the man who uses has recognized it.

Colonel Jack Berlin did not in his talk at Chicago use the same words we have used, but the meaning of what he said and of what we have said were one and the same.

Ray L. Dudley

BAKER

The "FIRST" Name in Floating Equipment

"First" in the Field

To have been the pioneer in developing and marketing floating equipment means little unless the wealth of knowledge acquired through years has been utilized to attain the position of "leadership" today.—By studying the performance of Baker Floating Equipment in cementing thousands of wells; by continuous "pioneering" as new materials could be incorporated into proven, as well as experimental designs, Baker always has maintained the lead, and is today unquestionably "First" in the Field.

"First" in Successful Results

Success in cementing means only one thing—to secure a leak-proof water shut-off with the initial cement job—and Baker Floating Equipment offers you the best possible opportunity to secure such success. Let us consider the features of Baker Equipment which contribute to Successful Results... Seamless steel collar stock, threaded to *exactly* fit your casing, is a long-time Baker "Standard." The rounded nose of all Baker Shoes is made of "Baker Formula" Cement, and will safely guide the casing past all side wall irregularities. The famous Baker Buoyant Ball permits free passage of the cement slurry; then, at the slightest reversal of pressure, floats to a leak-proof seal against the recessed, abrasion-resistant rubber ring.—All internal construction consists of easily drillable materials, with *no metal* to drill out or to interfere with diamond coring immediately below the shoe. The bit meets the very minimum cross-sectional area of plastic (and no metal) when drilling out, and quickly reduces the cement and plastic to harmless fragments which circulate out of the hole.

"First" and ONLY "Whirling" Action

This exclusive Baker development is widely used by operators who are willing to pay slightly more for this added assurance of success, especially when bridges are present in the hole. The baffled side ports in Baker WHIRLER Equipment direct the fluid at an angle against the walls of the hole, and this action combines with the hydraulicking effect of the fluid through the bottom of the shoe to remove bridges and permit safe landing of the casing. In addition, the well is conditioned to permit bonding of the slurry with the formation.

"First" in Popularity

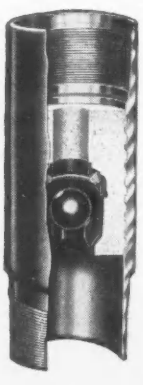
Here is a "First" possible only because you (and thousands of other operators) have been quick to recognize tools and methods which *provide dependable performance.* It is both a challenge and an inspiration to work with men who *insist upon results*—a challenge to supply their present needs, and an inspiration to meet their demands of tomorrow. Baker will always be ready!

BAKER OIL TOOLS, INC., • Houston • Los Angeles • New York

NO METAL • NO TRICKS • NO TROUBLE DRILLING OUT

This is Product No. 100—Baker Cement Float Shoe—outstandingly "First" for the safe guiding, floating and cementing of casing. No other shoe approaches its world wide popularity. Available also in the "Whirler" Type at a nominal increase in price.

This is Product No. 102—Baker Cement Guide Shoe. Used in combination with a Baker Cement Float Collar when one float valve is considered sufficient, and a stop for the cementing plug is desired above the shoe.



This is Product No. 101 M&F—Baker Cement Float Collar—usually positioned just above the shoe joint to provide a "stop" for the cementing plug. Used in combination with any type of Baker Cement Shoe selected to meet customer's specifications.

Brings "LASTING" Results

The Changing Panorama

Frozen Prices Chill Incentive

AS FORESEEN generally by oil producers, price and wage controls are proving harmful in the petroleum industry during the Korean conflict, just as they did during and following World War II. With oil prices frozen at pre-Korean levels, while wages and costs of materials are considerably higher, there is definite discouragement of efforts to find and develop oil reserves. This destruction of normal incentive would be against the public interest any time, but is especially so in this critical period when expansion of U. S. oil producing ability is urgently essential.

In a free market, prices of crude and products doubtless would undergo some corrections from present levels. But there might be some decreases as well as some increases. And certainly, any fluctuations would reflect weak, steady, or strong demand and thereby would discourage or encourage movement of oil supplies into the market.

Instead of this easy, unerring system of letting prices take care of themselves and achieve their function of properly determining inflow of supplies, there is now an illogical system of freezing prices, without regard to their effectiveness in bringing out needed supplies. The price is made all-important, and effect on supply of no consequence, though the consumer is concerned predominantly with supply and only secondarily with price.

Oil producers, through industry associations, currently are studying the possibilities of securing adjustments of crude prices by application to the Office of Price Stabilization. Judging by the poor results of similar applications in the World War II period, no high hopes for any early adjustments of oil prices are now justified.

Crude Ceilings Curb Stripper Production

THE COMPLICATIONS and dangers of price control are most strikingly evident in connection with stripper wells. Owners of these marginal wells, from which only relatively small profits can be squeezed, at best, are the first to be hurt by frozen prices in time of rising costs. Predominantly small independent operators, these producers are numbered by the thousands and their wells in several hundred thousands. Production from many of the wells is only a fraction of a barrel per well per day. Yet these wells are a very important source of supply for the nation's needs, yielding more than a million barrels of oil per day, or about one fifth of the country's total production. Sudden elimination of this production at present would mean the creation of a serious shortage. Discouragement of this marginal production by frozen crude prices similarly threatens curtailment of oil supply, even though it may be on more gradual basis.

As of January 1, 1951, the U. S. had 467,776 producing oil wells, of which 321,287, or approximately 68.7 percent, were classified as stripper wells. This was revealed in the national stripper well survey, conducted jointly by the Interstate Oil Compact Commission, the Independent Petroleum Association of America, and the National Stripper Well Association. In 1950 those stripper wells produced on the average 1,029,000 barrels of oil per day, or 19 percent of the total of 5,405,000 barrels daily produced in the nation.

The average daily production for stripper wells in 1950 was 3.2 barrels per well, while the average for all wells in the nation was 11.6 barrels per well. This stripper well oil was produced from 3,663,751 acres, which is approximately 22.5 percent of the total productive acreage in the nation.

It is estimated that underlying these 3,663,751 acres, the total reserves still possible to be recovered are 8,813,927,000 barrels, of which 4,235,455,000 barrels can be recovered by primary methods and 4,578,472,000 by secondary recovery.

Stripper wells are defined, in general, as those which, producing at their maximum unrestricted capacity, produce oil in such a volume that the profit from their operation is insufficient to warrant additional development in these fields. In many cases local conditions, such as the quantity of water produced, depth of the well, and age of the properties, warrant classifying these wells as stripper wells. In general, it can be said that two-thirds to three-fourths of the total oil that the well will produce has been produced at the time that it is classified as a stripper well, although in some instances, wells are classified as stripper wells almost from their initial production.

Gas to be Produced Under Barter Deal

ONE POSSIBLE way of minimizing the danger of control of natural gas production by the Federal Power Commission is seen in the barter transaction through which two major gas production companies recently agreed to exchange natural gas production. Gas in a Texas field will be exchanged for that in two Louisiana fields.

Under the agreement, covering a period of 20 years, Humble Oil & Refining Company will deliver to Southern Production Company 75 million cubic feet of gas daily from its Duck Lake and Lake Sand fields in Louisiana. Southern Production, in exchange, will supply Humble with the same volume from the Pledger field of Brazoria and Matagorda counties, Texas. Each company thereby will exchange gas that is not being used for gas in a different location that will be utilized.

The agreement provides for exchange of the gas above ground rather than in the ground. An originally considered plan of exchanging gas in place was abandoned because the U. S. Treasury Department ruled it would constitute a taxable exchange. The agreement decided upon is subject to Treasury Department confirmation that the exchange above ground is non-taxable.

There has been a serious threat that the Federal Power Commission may attempt to regulate as utilities any producing companies selling natural gas into interstate markets. Consequently, oil and gas producers generally are reluctant to sell gas that will go into interstate pipe lines.

Report from the Observatory

THREAT OF EXCESSIVE STOCKS FADES

By **RAY L. DUDLEY**, Publisher, and **WARREN L. BAKER**, Editor

ADDITIONAL REDUCTION of stocks, particularly of crude and distillate fuel oil, further enhanced the industry's economic position during the past month. Drafts on storage in November and December largely eliminated the previous threat of excessive inventories, present volumes in tanks not being as large as appeared probable back in September and October when production was above recent rates.

Consequently, the outlook for the petroleum industry is good as a new year starts. Stocks are adequate but not excessive. This is in contrast with conditions at the start of 1951, when small inventories of crude and distillate fuel oil left them in short supply and made it necessary to depend upon current production. A year ago gasoline was the only product inventory not considered adequate. The ability of the industry to enlarge its stocks during a period when it was experiencing peak demand far above previous volumes constitutes a remarkable achievement.

With volumes in storage now adequate in contrast with a short supply a year ago, less fluctuation in producing rates is indicated for 1952.

• • •

HIGHLIGHT OF THE PAST MONTH was the reduction in crude stocks, which had been climbing steadily since last March. U. S. inventories on December 8 totaled 259 million barrels of crude, down 2.1 million barrels from a month ago. The 75,000 barrel per day draft on these stocks was the result of high refinery runs and reduced output.

Nevertheless, crude stocks currently were still 12.7 million barrels greater than a year ago volumes. In contrast, crude stocks in January of 1951 were 10 million barrels under 1950 levels. Since the end of March a total of 26¾ million barrels have been added to crude oil storage tanks, and the increase was beginning to be worrisome.

A further reduction of crude stocks is in prospect for January. Texas daily production allowable for the month has been set at 85,000 barrels per day under that of December.

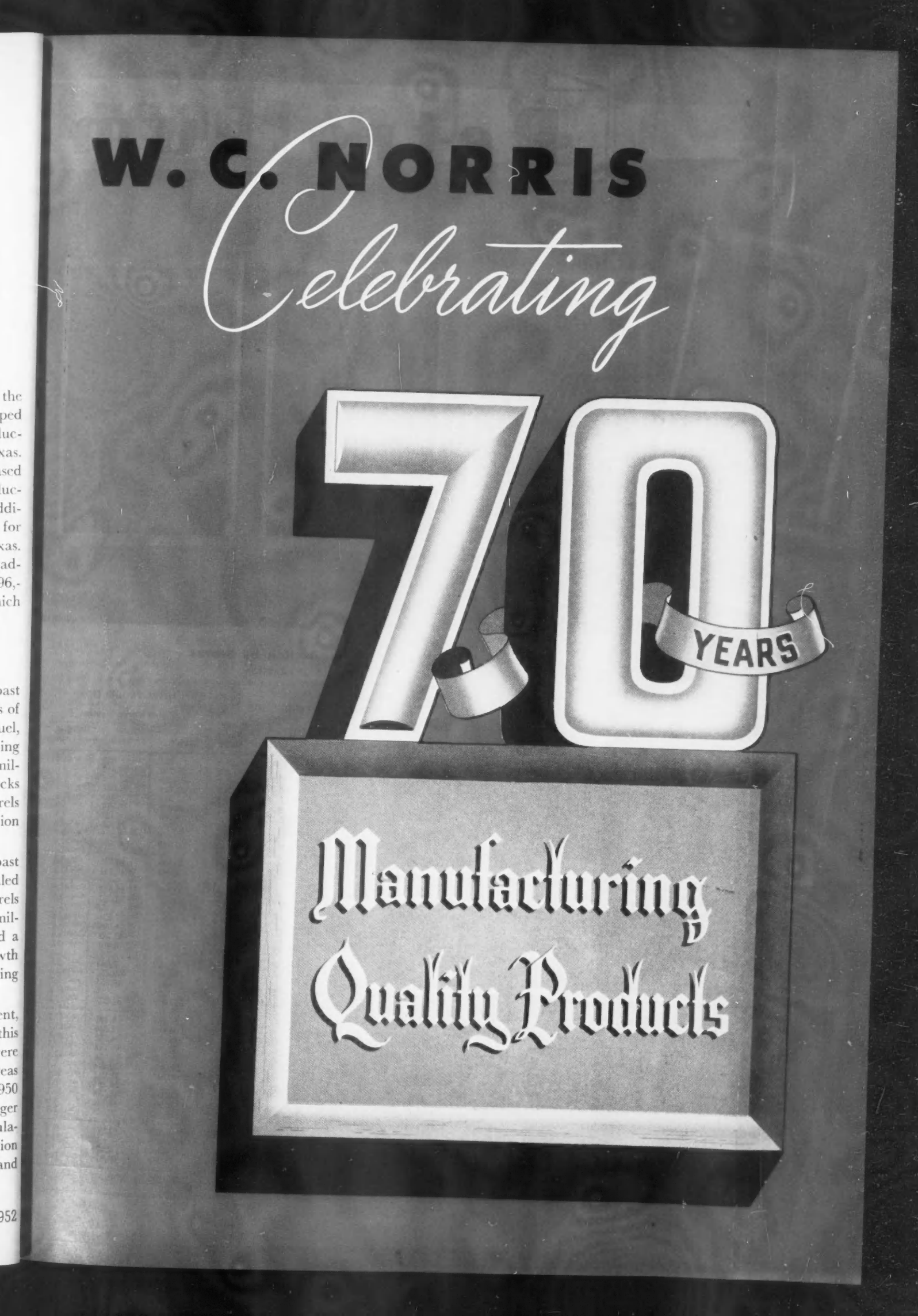
Total figures for the nation, however, do not reflect the full extent of the improvement in crude stocks during the past month. Crude inventories in Illinois-Indiana dropped nearly ½ million barrels last month, while minor reductions occurred in Oklahoma, Kansas and West Texas. Crude stocks in all these areas had previously increased to the point they were becoming excessive, and the reduction of the past month was a significant change. Additional drafts on stocks in these regions is indicated for January because of the reduced output in West Texas. Meanwhile, the past month saw crude inventories advance by 260,000 barrels in the East Coast and by 496,000 barrels in the Texas Gulf Coast, two areas which have been in short supply.

• • •

IMPROVEMENT has occurred during the past month in the refined product inventory picture. Stocks of the four leading refined products (gasoline, distillate fuel, residual fuel and kerosine) receded sharply, declining 12.9 million barrels from a month ago to total 279 million in mid-December. However, at this new level stocks of these four products were still 26.4 million barrels greater than in 1950. But they had been 33.1 million barrels larger two months ago.

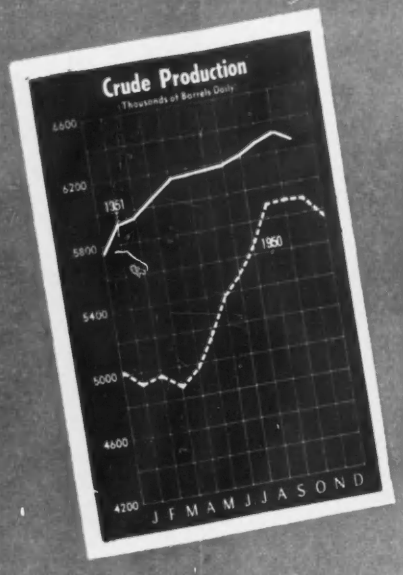
Declining by 315,000 barrels per day during the past month, distillate fuel oil stocks in mid-December totaled 91.6 million barrels. This volume was 14.7 million barrels above year-ago levels, slightly higher than the 13.3 million barrel margin over 1950 quantities which existed a month ago but still under the 18.3 million barrels growth shown in mid-October. Cold weather could easily bring further narrowing of this margin of difference.

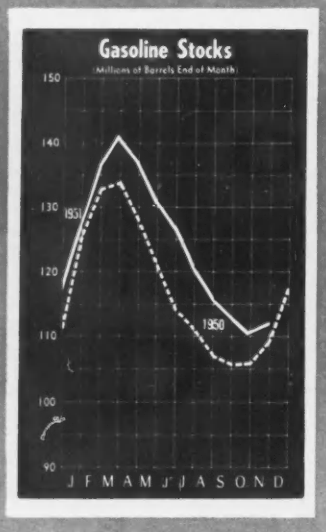
Gasoline inventories continued to show improvement, although experiencing the usual seasonal growth for this time of year. By mid-December, these inventories were only 3.8 million barrels larger than a year ago, whereas a month ago they were 4.9 million barrels above 1950 volumes and in September were 8 million barrels larger than in the corresponding period of 1950. Proper regulation of refinery yields can now prevent the accumulation of too much motor fuel in stock tanks between now and the start of the consuming season next April.

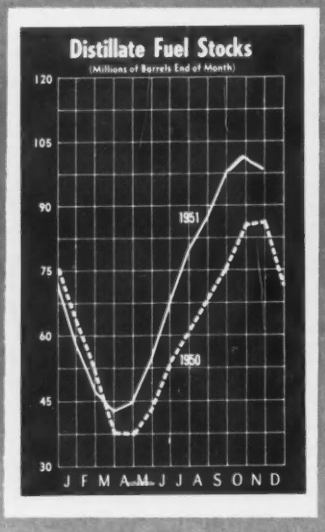

W. C. NORRIS
Celebrating
70
YEARS
Manufacturing
Quality Products

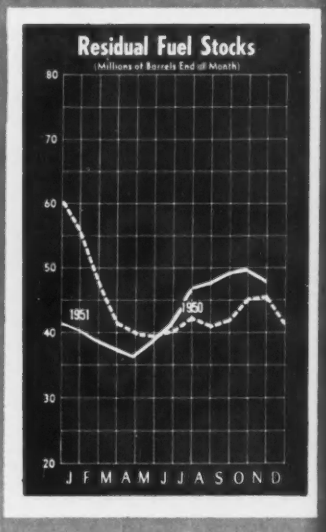
Petroleum

By CECIL W. SMITH









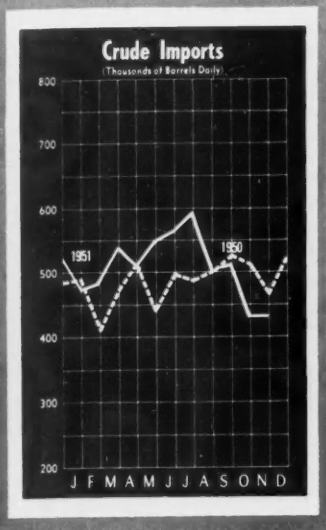
U. S. Crude Production by States

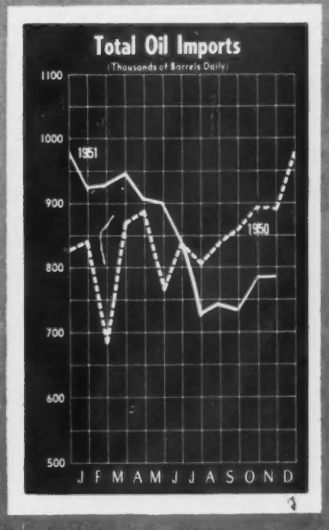
(THOUSANDS OF BARRELS)

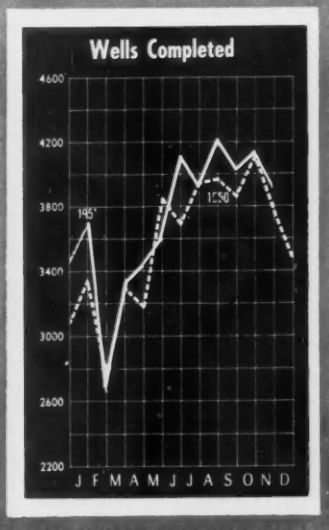
STATE or DISTRICT	DAILY AVERAGE PRODUCTION				TOTAL PRODUCTION First Eleven Months		
	November, 1951	October, 1951	November, 1950	% Diff. Nov. '51-'50	1951	1950	% Diff. '51-'50
Alabama	2.9	3.0	2.5	+ 16.0	953	651	+ 46.4
Arkansas	81.3	82.1	83.1	— 2.2	27,250	28,544	— 4.5
California	984.8	988.4	956.9	+ 2.9	324,495	297,902	+ 8.9
Colorado	77.4	78.4	74.9	+ 3.3	24,911	21,027	+ 18.5
Florida	1.6	1.6	1.7	— 5.9	544	441	+ 23.4
Illinois	165.9	170.7	165.5	+ 0.2	54,066	56,874	— 4.9
Indiana	31.8	33.1	27.2	+ 16.9	9,708	9,123	+ 6.4
Kansas	313.5	320.0	304.6	+ 2.9	104,872	98,236	+ 6.8
Kentucky	34.1	33.0	29.9	+ 14.0	10,414	9,398	+ 10.8
Louisiana	637.8	649.2	611.5	+ 4.3	211,999	190,264	+ 11.4
North Louisiana	124.7	125.3	120.6	+ 3.4	39,918	40,523	— 1.5
South Louisiana	513.1	523.9	490.9	+ 4.5	172,081	149,741	+ 14.9
Michigan	37.0	38.3	40.6	— 8.9	12,860	14,572	— 11.8
Mississippi	102.1	106.3	107.7	— 5.2	34,127	35,027	— 2.6
Missouri	0.1	0.1	0.1		26	26	
Montana	24.8	25.2	22.7	+ 9.3	8,242	7,374	+ 11.8
Nebraska	7.6	7.5	7.2	+ 5.6	2,361	1,298	+ 81.9
New Mexico	147.9	143.5	133.6	+ 10.7	47,883	43,788	+ 9.4
New York	13.5	13.8	11.0	+ 22.7	4,009	3,801	+ 5.5
North Dakota	0.1	0.1			17		
Ohio	8.4	9.3	7.6	+ 10.5	2,901	3,084	— 5.9
Oklahoma	509.5	507.9	495.6	+ 2.8	170,160	149,437	+ 13.9
Pennsylvania	27.7	29.2	32.1	— 13.7	10,241	10,855	— 5.7
Tennessee	0.1	0.1			15	19	— 21.1
Texas	2,834.9	2,899.8	2,588.6	+ 9.5	922,472	754,503	+ 22.3
Dist. 1—South Central	33.5	34.9	31.2	+ 7.4	11,152	9,491	+ 17.5
Dist. 2—Middle Gulf	170.0	175.0	151.1	+ 12.5	55,002	44,380	+ 23.9
Dist. 3—Upper Gulf	491.5	514.3	463.0	+ 6.2	165,337	136,752	+ 20.9
Dist. 4—Lower Gulf-S.W.	260.3	270.9	232.4	+ 12.0	85,767	69,743	+ 23.0
Dist. 5—East Central	54.4	55.3	43.0	+ 26.5	17,552	11,936	+ 47.1
Dist. 6—Northeast	402.1	393.8	392.5	+ 2.4	130,458	120,184	+ 8.5
Dist. 7-B—North Central	83.5	86.6	72.4	+ 15.3	27,607	23,015	+ 20.0
Dist. 7-C—West Central	120.1	117.6	79.3	+ 51.5	34,714	20,394	+ 70.2
Dist. 8—West	977.9	1,005.8	872.6	+ 12.1	313,985	241,336	+ 30.1
Dist. 9—North	158.3	161.4	150.0	+ 5.5	51,994	48,132	+ 8.0
Dist 10—Panhandle	83.3	84.2	90.0	— 7.5	29,193	30,363	— 3.9
Utah	3.4	3.5	3.6	— 5.6	1,228	1,094	+ 12.2
Virginia	0.1	0.1			15	19	— 21.1
West Virginia	7.4	7.9	6.5	+ 13.8	2,532	2,576	— 1.7
Wyoming	179.6	181.4	176.1	+ 2.0	62,212	54,636	+ 13.9
Total United States	6,235.3	6,333.5	5,890.8	+ 5.8	2,050,513	1,794,569	+ 14.3

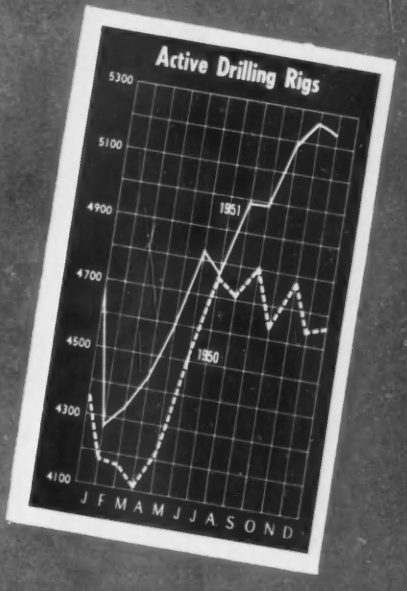
Trends in U. S.

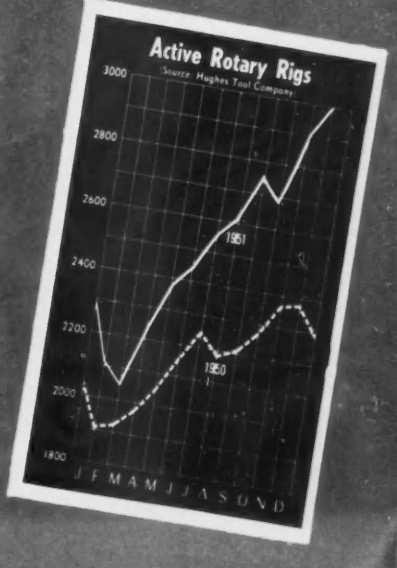
WORLD OIL Staff











Crude Oil and Refined Products Trends

(THOUSANDS OF BARRELS)

MONTH	CRUDE OIL			GASOLINE		DISTILLATE FUEL		RESIDUAL FUEL		DAILY IMPORTS	
	Production Daily	Runs to Stills Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Production Daily	Stocks End of Month	Crude Oil	Total Oils
1949:											
November	5,210	5,293	256,010	2,594	104,707	962	88,212	1,180	65,112	435	703
December	5,024	5,475	253,356	2,633	111,521	1,032	75,207	1,203	60,193	485	828
1950:											
January	4,922	5,483	246,610	2,575	125,298	1,048	63,932	1,209	55,808	487	841
February	4,967	5,316	243,750	2,552	132,796	1,026	52,206	1,172	47,828	411	684
March	4,878	5,336	241,098	2,539	133,766	938	37,777	1,154	41,860	471	869
April	4,968	5,193	244,605	2,508	128,057	977	37,530	1,048	39,979	511	888
May	5,143	5,535	239,877	2,647	121,035	997	42,739	1,063	39,482	439	766
June	5,378	5,655	242,287	2,748	114,074	1,037	53,679	1,069	40,124	498	838
July	5,484	5,882	240,270	2,835	111,055	1,040	62,555	1,140	42,165	486	806
August	5,665	6,067	237,393	2,932	107,067	1,089	68,426	1,148	40,979	501	839
September	5,888	6,059	242,311	2,849	105,748	1,180	78,270	1,178	41,966	525	859
October	5,900	6,077	246,424	2,875	105,764	1,217	85,643	1,250	45,004	510	896
November	5,891	6,085	250,016	2,859	109,005	1,218	86,113	1,240	45,048	466	891
December	5,758	6,092	247,814	2,872	117,220	1,307	70,875	1,280	41,184	521	979
1951:											
January	5,907	6,450	243,107	2,962	128,479	1,427	58,424	1,368	40,317	499	977
February	5,930	6,562	235,247	2,906	137,243	1,419	47,587	1,382	39,409	468	937
March	6,052	6,469	233,824	2,908	141,456	1,327	42,978	1,348	37,516	483	861
April	6,127	6,183	243,180	2,821	139,188	1,171	44,736	1,230	36,910	511	871
May	6,170	6,436	248,418	3,031	132,261	1,210	55,273	1,265	39,317	518	876
June	6,130	6,575	248,170	3,100	127,595	1,254	67,839	1,277	41,566	563	876
July	6,141	6,462	250,847	3,091	121,482	1,228	79,437	1,275	45,163	546	788
August	6,232	6,539	254,276	3,114	114,446	1,237	87,432	1,226	47,243	529	780
September	6,261	6,558	254,900	3,127	114,147	1,282	96,241	1,228	48,212	500	744
October	6,333	6,483	261,171	3,114	110,203	1,320	102,575	1,210	48,825	429	734
November	6,235	6,648	260,839	3,146	111,809	1,375	98,603	1,314	47,477	431	790
Nov., 1951 Change:											
In Month	−98	+165	−332	−178	+1,606	+55	−3,972	+104	−1,348	+2	+56
In Year	+344	+563	+10,823	+77	+2,804	+157	+12,490	+74	+2,429	+35	+101
Week Ended:											
12-15-51	6,225	6,553	259,085	3,182	114,812	1,467	91,649	1,252	44,157	405	751
12-16-50	5,723	5,925	247,274	2,893	110,943	1,266	76,913	1,224	41,598	575	1,078

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SHARE-THE-SHORTAGE IS PHILOSOPHY OF DESPAIR

Guest Edited

By ROBERT G. DUNLOP, President, Sun Oil Company

A PAGE from the doctrine of Karl Marx has become the blueprint for economic relations among countries of the free world as they gird for common defense against Soviet aggression.

It is a paradox that threatens the taproot of the free world's strength—American industry.

Little noticed by the American people, a super-governmental body, the International Materials Conference formed under the aegis of the State Department in January of 1951, has established full-blown cartel machinery to allocate and fix prices for strategic commodities in international trade. The guiding principle in its actions parallels the Marxian philosophy of taking from each according to his ability and giving to each according to his need.

The program of the conference is to decide which nation gets how much of what raw material, allocating supplies and fixing prices to the end that each country's quota (called "Entitlement for Consumption") is filled. The conference is an outgrowth of a proposal by former Prime Minister Atlee that the governments of the North Atlantic Treaty Organization agree on an "equitable" division of the world's resources.

Among its achievements, the conference takes credit for "reducing ruthless competition for supplies." It also takes a bow for establishing a "mechanism" for the consideration of the needs of non-member countries, in the absence of which "there would be no assurance to them that they would receive equitable treatment in the competition for materials in short supply."

In none of its pronouncements has the conference considered the possibility of a free market equating supply and demand and channeling materials to the most efficient producers.

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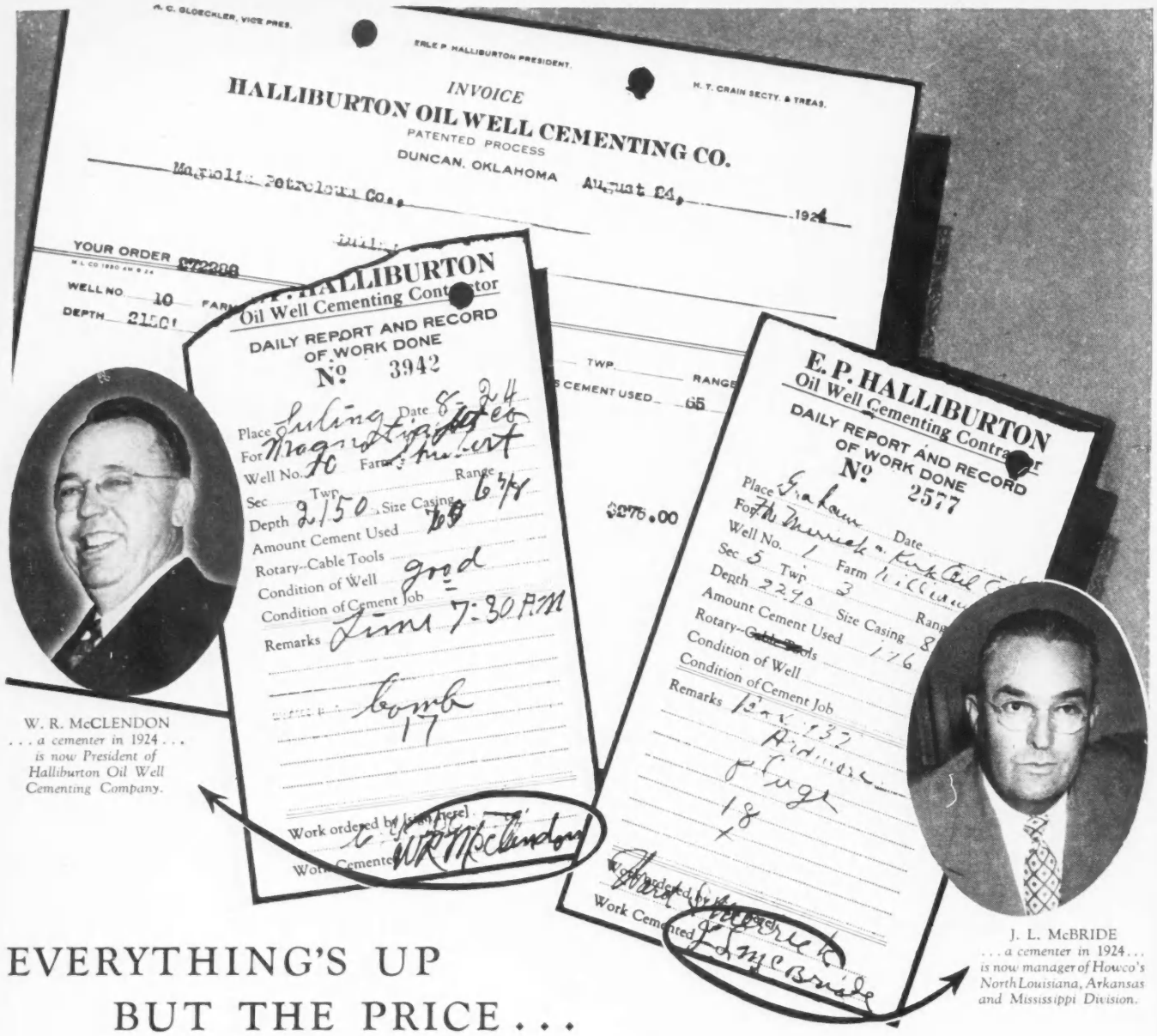
THE CONSEQUENCE of this global share-the-shortage scheme far transcends the materials supply problem of the petroleum industry, or of all U. S. manufacturers. It involves the jeopardy of the cause for which the free world is currently attempting to mobilize its resources. To parcel out critical raw materials not upon considerations of efficiency and ability to manufacture, but upon the basis of something strangely called "entitlement for consumption," is to waste industrial capacity upon which successful mobilization depends.

Invalidation of the laws of supply and demand is a poor way to begin a program designed to increase production of material wealth and implements of defense.

The U. S. is today the mainstay of the free world primarily because American industry has been permitted to operate with greater economic freedom than has industry in any other corner of the globe. No industry more dramatically demonstrates the effectiveness of competition and opportunity to respond to the forces of a free market than does the petroleum industry. Its response to a free market has been in reality a response to the needs of the citizens and the Nation—and every need has been met. To pervert the expression of these needs through the imposition of cartelistic controls is to cripple industry's performance and consequently reduce the volume of goods produced.



W. R. McCLENDON
. . . a cementer in 1924 . . . is now President of Halliburton Oil Well Cementing Company.

J. L. McBRIDE
. . . a cementer in 1924 . . . is now manager of Howco's North Louisiana, Arkansas and Mississippi Division.

EVERYTHING'S UP BUT THE PRICE . . .

The men have gone up. W. R. McClendon, a cementer in 1924, is now President of the Halliburton Company. J. L. McBride, also a cementer in 1924, is now manager of Howco's North Louisiana, Arkansas, and Mississippi Division.

The cost of cementing trucks has gone up—from $6,000 in 1924 to more than $50,000 today.

Cementers' wages have gone up by more than 70%.

Only one element of a cementing job has gone down. The price of the average job today is less than it was in 1924!

Erle P. Halliburton

Chairman of the Company

HALLIBURTON OIL WELL CEMENTING CO.
Duncan, Oklahoma

Monthly News Analysis

Texas Allowables Reduced For Third Straight Month

The oil industry is in a fairly satisfactory position with regard to stocks of crude and principal refined products, it was indicated at the statewide proration hearing of the Texas Railroad Commission at Austin December 19.

The commission took a conservative view that stocks were too high and ordered an 86,000-barrel cut in Texas allowable crude production for January. This was the third monthly reduction in succession and lowered quotas 225,000 barrels daily below October.

However, some major purchasers had recommended keeping allowables unchanged or somewhat increasing them, with Humble Oil & Refining Company and Sun Oil Company stating they were short of certain grades of crude, particularly Gulf Coast crudes.

In recommending higher allowables, Herman Pressler, a spokesman for Humble, pointed out that U. S. refinery runs are at record levels, being up more than 10 percent over a year ago. This was called justification for crude stock levels at least 10 million barrels above a year ago. (Present stocks are about that amount above a year ago.) Concerning Texas, he said crude stocks are up 6,578,000 barrels over a year ago, to 126,075,000 barrels, but the increase all is in West Texas and East Texas, leaving the Gulf Coast and other areas with less crude than last year. This calls for increased total stocks or readjustment of grades on hand, he contended. U. S. crude stocks are larger than a year ago by about 13 million barrels, but nearly all of the increase exists in West Texas, the Rocky Mountains, and the Oklahoma-Kansas and Illinois-Indiana districts.

Another Humble company representative, J. A. Neath, vice president, pointed out a reasonable relationship between stocks of major refined products and the trends of demand for those products. He cited December 8 levels of U. S. petroleum product stocks, including gasoline inventories of 113,600,000 barrels, up 3.6 percent from a year ago; middle distillates 123,600,000 barrels, up 16 percent; and residuals 46,200,000 barrels, up 6.7 percent. For the first nine months of 1951, he said, gasoline demand increased 11.3 percent over 1950; middle distillates increased 14 percent; residuals 4.7 percent. An over-all increase of 5 percent in petroleum demand is predicted for 1952 over 1951, he added. Neath described gasoline stocks as adequate and would not concede under questioning that they were too high. Other products are not in oversupply, he stated, considering present cold weather in the North and East and the growing market demand.

Neath also discounted the idea that an oversupply of petroleum and products and a break in prices might occur if Iranian crude and products re-entered the markets. He said it would require several months after settlement of the Iranian situation to get Iran's oil back on the market. He did not consider plausible the speculation that Middle East producers outside Iran, such as those of Kuwait and Saudi Arabia, would cut prices in an effort to hold markets that were gained as a result of the shutdown of Iranian production and refining.

Price Controls Disregard Supply-Demand Balance

Existing price controls are obviously perpetuating oil industry prices that are no longer fair and at the right levels to make supply and demand balance. In the case of both crude and refined products, there are various situations where upward price adjustments are necessary to assure adequate supply to meet demand. But the increases which obviously would be made under normal conditions are precluded by the freeze of virtually all oil prices.

In the Middle Atlantic and New England areas, shortages of heating oils are threatened, with prices of the oils frozen and supplies curtailed because the prices do not cover sharply increased tanker rates.

Domestic crude producers are being denied increases in prices that would be made normally on certain crudes that are in strong demand. For example, the Office of Price Stabilization for several weeks has been putting off action on a proposed increase of Spraberry type crude of West Texas from $2.58 to $2.65 per barrel. Six major purchasers queried by OPS expressed no objection to the increase and indicated they would willingly pay the higher price if OPS authorized it. Although OPS had not taken action late in December, there was indication it might permit the raise, as it had determined that principal purchasers would approve on the basis that the Spraberry crude was comparable to other crudes priced at $2.65.

Meanwhile, counsel for Independent Refiners Association of America filed a demand with OPS that any crude price increase be accompanied by proportional upward adjustment of ceilings on petroleum product prices. That association indicated it had no objection to crude price increases and in fact recognized the necessity for crude oil ceiling adjustments.

But counsel for the association declared "Refining profits are no better today than they were in the base period (before price controls); and consequently, increases in raw material costs must be offset by appropriate changes in ceiling prices for products."

However, OPS has intimated that it has no intention of adjusting product prices generally on the basis of special crude price adjustments such as that proposed for Spraberry type crude. The price control agency contends that refiners' ceilings reflect the general or over-all crude oil market at time of price freezing. Since the Spraberry ceiling may be classed as having been below the general level for other comparable crudes, OPS reasons that refiners can absorb any increase that might be granted to raise the Spraberry ceiling to the general level.

PAD Survey to Determine Best Use of LPG Storage

Petroleum Administration for Defense will try to minimize shortages of liquefied petroleum gas. It has sent questionnaires to about 13,000 LPG producers, marketers, distributors, and dealers to determine available storage facilities. Through information developed, PAD will try to insure maximum use of available storage in case

of emergency and will recommend expansion where necessary.

Increases in LPG use have been spectacular in recent years, and sudden developments in defense needs could place a heavy burden on the industry.

Materials Division of PAD Realigned in Three Groups

The Materials Division of Petroleum Administration for Defense has been reorganized to emphasize procurement of critical components. The various branches of the division have been realigned in three groups, each under an assistant director aiding Director Richard M. Morrison. The assistant directors are Herbert R. Hansen, responsible for program coordination and administration; Hugh R. Lamberth, material procurement; and George W. Knight, coordination of materials for foreign petroleum operations.

An important purpose of the reorganization is to improve liaison with Defense Production Administration and National Production Authority, so as to keep those agencies advised of PAD's requirements for all major material items and to keep PAD's operating divisions advised as to the availability and lead time of all materials and equipment in short supply.

PAD Rules on Tubular Goods Purchases by '1-11' Group

Contrary to reports that the small drilling operators are required to purchase their tubular goods at Petroleum Administration for Defense warehouses, PAD has announced that operators who normally put down from 1 to 11 wells per year may obtain their oil country tubular goods from their regular supply stores.

Procedure for the 1 to 11 operator to follow has been explained.

- He must file before the announced deadline with PAD a form PAD-17, presenting his scheduled requirements for casing and tubing in the following quarter.
- If his application for priorities assistance is granted, he will receive a letter from PAD setting forth the total tonnage of oil country tubular goods he will be permitted to draw from stocks during the quarter. With this letter his PAD-17 will be returned.
- When the operator is preparing to begin actual drilling, he must file with PAD at least 15 days before the material is needed four copies of PAD-15 for each well he has programmed. Specific authorizations of quantities will be made on the basis of the PAD-15, and the operator will be given an allotment symbol to let him purchase the needed casing and tubing from his regular supply store.

Certain time limits are imposed on the operator. He must begin drilling within 30 days after he places his orders. He may not accept delivery of surface or intermediate casing earlier than five days before he installs it or of oil or flow string or tubing earlier than 72 hours before he installs it.

This procedure does not apply in the case of operators who are drilling wildcat wells and want to draw on PAD's 5 percent field warehouse set-aside. Such operators must get their supplies from the warehouse.

Completion Record Hung Up By Southwest Texas Well

The Hiawatha Oil & Gas Company's George Parr B-1, Duval County, Texas, was completed to 14,110 feet in 46.67 days by Allen & Morris, San Antonio drilling contractors. This total rig time on location established a record for Southwest Texas.

Operators attribute rapid completion to the use of five-inch outside diameter (19.5-pound grade 'E') drill pipe, oil emulsion mud, and precision timing of drilling crew and rig action.

Operations included 30 round trips with drill pipe; 6 electric, 1 caliper, and 1 temperature survey; 24 single shot surveys; 2 sidewall sample trips; landing 13⅜-inch casing at 537 feet; setting 9⅝-inch casing at 7499 feet; and waiting on cement approximately five days.

An average of 302.34 feet were drilled each day. On the basis of drilling time on bottom, an average of 584.02 feet were made daily. Minutes per foot to total depth figured 2.47 for drilling and reaming time.

Several time-consuming problems were encountered during the operation. Partial circulation was lost at 4600 feet; heaving shale was encountered from 7000 to 7500 feet; a thief formation interrupted circulation while cementing the 9⅝-inch casing; and circulation was again lost at 11,980 feet. Difficulties were intensified below 7000 feet by heaving shale and high-pressure shale gas which tended to cut the 17.3-pound per gallon emulsion mud. From this depth to the bottom of the hole, the filtrate rate of the circulating medium was maintained at 3.5 cubic centimeters or less. Conditioning of the mud system required 2,644,980 pounds of admixes. The precision control of this fluid expedited the rate of penetration and imposed sufficient force to cause gas and heaving shale to "lay back."

Major Alterations in PAD Policies Believed Unlikely

It is unlikely that any significant alterations will be made in over-all policies of Petroleum Administration for Defense, despite some changes in 1952 in its top personnel.

In its major function as claimant agency for getting allocations of controlled materials for the petroleum industry, PAD can only make requests for allotments of steel and other critical materials, subject to supplies allocated by National Production Authority's Defense Production Administration. General policies for such allocations are determined by members of the Truman Cabinet. And as Secretary of Interior, Oscar L. Chapman will continue as Petroleum Administrator, directing operations of PAD regardless of oil industry representatives in the agency.

However, the newcomers in PAD administration, fresh from industry operations, have experienced the impact of PAD policies, methods, and regulations, and may be able to bring to the agency recommendations growing out of their recent experiences. In this way there may be some progress toward reducing the labyrinth of red tape inherent in industry's dealings with any government agency.

Stepping into PAD's top operating spot as deputy administrator on June 1 will be J. Ed Warren, who recently completed a two-year tenure as president of Independent Petroleum Association of America. Following that service and his many other industry associations, such as a member of National Petroleum Council, Military Petroleum Advisory Board and formerly president of American Association of Oil Well Drilling Contractors, Warren is well qualified to serve in the PAD high post. He will join PAD April 1 to serve as assistant to Bruce K. Brown, the first deputy administrator, who has expressed for some time the desire to return to his position as president of Pan-Am Southern Corporation.

Other new officials in PAD will include R. L. Foree, president of Texas Independent Producers and Royalty Owners Association, who will move into a PAD office January 1 to succeed Richard Lawton as director of the production division.

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Year's Completions Set Record as Predicted

IN THE first 11 months of 1951, the U. S. petroleum industry drilled and completed 41,597 wells to top the previous year's comparable period by almost 3 percent. Of that total, 40,900 were new wells, with the remainder being old wells drilled deeper.

At the beginning of 1951, WORLD OIL forecast 44,945 new wells in the U. S. Again at the middle of the year, the firms that drill a large part of the nation's wells were queried as to their plans for the remaining six months, and a new estimate was based partly on the results of this canvass. The net change to the original estimate was the addition of only 20 new wells to the nation's total.

With only one month's records yet to be compiled, it appears that WORLD OIL's forecast of 44,965 new wells in 1951 will be close to the exact figure. That, of course, will be a new all-time high, as the 43,307 new wells finaled in 1950 at present occupies top position.

Making 1951 an even greater drilling year than will the record number of wells, will be the amount of footage drilled. The previous year's 160 million feet was by far the most drilled in a single year, but 1951 will beat that record by more than 13 million feet of hole.

The year's drilling has not met with quite the success as the previous year's program. So far in 1951, 53 percent of the tests drilled in search of oil or gas production have been completed as oil producers, while in the same period a year earlier almost 57 percent were completed as oilers. Distillate and dry gas producers amounted to about the same percentage of the total in both periods, but 1951's dry holes accounted for 39 percent, while only 35 percent were dusters the year before.

Well Completions in the United States During November, and First Eleven Months, 1951

(Figures compiled by WORLD OIL Staff from private reports and other sources as follows: Illinois from Illinois Geological Survey: Indiana from Indiana Division of Geology; Missouri from Missouri Geological Survey; Tennessee from Tennessee Division of Geology; Bradford, Kane-Clarendon and Allegany fields of Pennsylvania and New York from the "Producers Monthly.")

State or District	MONTHLY COMPLETIONS, NOVEMBER, 1951									TOTAL COMPLETIONS				CUMULATIVE TOTALS January-November					Rigs in Operation (Drilling, Rigging-Up and Shut Down)		
	NEW WELLS								Total Drilled Deeper												
	Oil	Dist.	Gas	Dry	Water Input	Gas Input	Water Disposal	Total New		Nov., 1951	Oct., 1951	Nov., 1950	Footage Nov., 1951	1951	1950	Percent Diff.	Footage 1951	Footage 1950	Nov. 30, 1951	Oct. 31, 1951	Nov. 30, 1950
Alabama				2				2		2	3	4	11,526	51	41	+ 24.4	249,545	176,557	4	4	8
Arizona				1				1		1		3	2,298	4	8	— 50.0	8,635	32,108	2		3
Arkansas	20		1	17				38		38	42	38	151,045	392	358	+ 9.5	1,383,728	1,187,562	36	37	37
California	133		2	47				182	7	189	255	204	701,271	2,248	1,747	+ 28.7	8,630,627	7,039,491	275	271	192
Colorado	15		5	19				39		39	33	9	195,142	264	76	+247.4	1,283,882	313,325	47	44	25
Florida														3	11	— 72.7	14,614	69,518	2	1	1
Georgia															3	—100.0		13,270			
Idaho												1		1	5	— 80.0	12,844	16,367	1	1	1
Illinois	63		3	122				188		188	232	246	485,966	2,186	2,640	— 17.2	5,444,963	5,753,533	228	201	250
Indiana	36			70				106		106	158	154	191,039	1,216	1,486	— 18.2	2,201,080	2,550,784	184	182	194
Kansas	218		17	187			3	425		425	366	296	1,498,336	3,905	3,598	+ 8.5	13,408,263	11,594,013	433	434	333
Kentucky	35		20	53				108	1	109	123	110	229,684	1,198	1,150	+ 4.2	2,457,870	2,130,771	106	103	110
Louisiana	108	15	21	88				232	1	233	192	198	1,365,572	2,083	2,262	— 7.9	13,103,489	13,586,483	247	253	252
North Louisiana	69	9	19	56				153	1	154	101	112	616,951	1,176	1,208	— 2.7	4,504,897	4,249,177	73	78	88
South Louisiana	39	6	2	32				79		79	91	86	748,621	907	1,054	— 14.0	8,598,592	9,337,306	174	175	164
Maryland			3	4				7		7	4		29,117	37	4	+825.0	155,430	16,636	31	31	5
Michigan	20		1	36				57		57	63	85	156,415	652	785	— 17.0	1,646,142	1,915,945	114	122	116
Mississippi	5		1	34				40		40	39	18	279,582	352	302	+ 16.6	2,343,068	2,170,539	36	38	27
Missouri												1		4	27	— 85.2	2,717	21,482	5	5	6
Montana	8		1	12				21	2	23	35	28	66,661	258	255	+ 1.2	609,922	633,647	49	39	37
Nebraska	2		4	13				19		19	26	8	91,018	164	98	+ 67.3	782,496	410,451	20	18	10
Nevada												2		2	2		15,431	14,439	1	1	
New Mexico	43		15	9				67	1	68	70	51	312,467	648	572	+ 13.3	3,176,830	2,535,034	166	187	87
New York	30				21			51		51	42	43	72,681	494	687	— 28.1	705,904	1,006,753	56	54	92
North Carolina																					
North Dakota				1				1		1	1		4,144	9			44,419		11	6	2
Ohio	26		22	35				83		83	94	85	172,974	854	924	— 7.6	1,731,738	1,897,864	156	156	156
Oklahoma	249		24	169	7		2	451	11	462	552	468	1,769,902	5,181	5,004	+ 3.5	18,627,810	17,615,901	631	649	671
Oregon																					1
Pennsylvania	59		11	8	55	7		140	3	143	158	153	242,496	1,440	1,527	— 5.7	2,469,847	2,773,695	243	244	250
South Dakota				2				2		2		1	3,340	2	6	— 66.7	3,340	19,397	3	3	
Tennessee														6	3	+100.0	7,465	3,993	7	7	7
Texas	869	27	69	538	4	1	1	1,509	24	1,533	1,513	1,549	7,063,244	16,615	15,672	+ 6.0	72,744,752	66,702,359	1,801	1,835	1,469
Dist. 1 S. Central	35			36				71	2	73	44	69	182,822	584	486	+ 20.2	1,602,039	1,441,899	49	51	34
Dist. 2 Middle Gulf	30	7	12	37				86		86	56	61	505,459	724	647	+ 11.9	4,253,145	3,725,614	66	78	50
Dist. 3 Upper Gulf	63	6	2	45				116		116	127	121	749,967	1,406	1,440	— 2.4	8,781,072	8,536,904	122	124	144
Dist. 4 L. Gulf-S.W.	78	11	10	61		1		161		161	121	173	899,421	1,584	1,553	+ 2.0	7,887,247	7,500,421	122	119	104
Dist. 5 E. Central	17			22				39		39	36	23	179,642	443	188	+135.6	1,831,745	841,196	29	30	22
Dist. 6 Northeast	17	2	10	19				48		48	53	78	262,703	635	635		3,270,081	3,050,426	45	43	37
Dist. 7-B N. Cent	84		4	104	4		1	197	1	198	211	197	563,907	2,563	1,901	+34.8	7,435,687	5,214,609	188	186	147
Dist. 7-C W. Cent	108			42				150		150	141	94	798,337	1,389	900	+ 54.3	6,516,157	3,563,509	255	253	105
Dist. 8 West	294		1	44				339	19	358	340	424	1,943,051	3,720	3,961	— 6.1	20,288,287	21,338,283	528	558	484
Dist. 9 North	120	1	2	116				239	2	241	325	230	755,902	2,741	2,975	— 7.9	8,227,506	8,400,529	272	269	239
Dist. 10 Panhandle	23		28	12				63		63	59	79	222,033	826	986	— 16.2	2,651,786	3,089,969	125	124	103
Utah	2		1	4				7		7	2	2	47,064	34	21	+ 61.9	174,085	80,853	33	29	10
Virginia																			1	1	1
Washington															2	—100.0		16,032	1	1	
West Virginia	8		45	14				67		67	90	47	189,596	602	595	+ 1.2	1,714,288	1,534,784	200	205	210
Wyoming	20			26				46		46	77	47	256,248	692	548	+ 26.3	3,476,914	2,694,248	104	98	86
Total U. S.	1,969	42	266	1,511	87	8	6	3,889	50	3,939	4,170	3,851	15,588,828	41,597	40,419	+ 2.9	158,632,138	146,527,834	5,234	5,260	4,649

What's Ahead in '52...?

Executives List Taxes, Prices, Steel Among Major Problems In Year Ahead

WHAT is the oil industry's major problem in 1952? Executives of some of the top producing companies in the U. S. were asked this question in WORLD OIL's annual symposium.

Their answers reflect the present global uncertainty and domestic confusion:

- Enough oil to meet any crisis.
- Fair prices to encourage the search for oil.
- Reasonable taxes to heighten incentive.
- More steel.
- Freedom from oppressive regulations.
- Development of oil resources abroad on a fair and equitable basis.

The executives' statements in full:

L. F. McCOLLUM
President, Continental Oil Company

THE basic problem of the oil industry during recent years has been that of meeting rapidly increasing current civilian and military demands for petroleum products. The recurring crises caused by the unsettled international situation impose an additional task on the industry of being prepared for possible sudden emergencies. Obviously, the creation of reserve capacity in crude production over and above current needs has to be done by the industry itself, since no government agency could engage successfully in finding and developing crude reserves. The record of the industry during two major wars is adequate proof that it is capable of fulfilling its responsibilities to the nation and the consuming public. The dynamic nature of the industry was again forcefully demonstrated in 1951 when, despite materially higher military and civilian requirements and increased exports which were needed to replace in part the loss of Iranian oil, no shortages of any nature developed.

L. F. McCollum

There is every reason to believe that this nation will be assured an adequate supply of liquid fuels in times of peace and war if the prerequisites which enabled the oil industry to achieve its present record remain unimpaired. Among these prerequisites are the economic incentives needed by the industry to do the job. These, in turn, mean among other things freedom from excessive taxation, freedom from oppressive arbitrary regulations, and a level of earnings which would permit the industry to generate within itself sufficient capital funds for replacement and normal expansion purposes. In addition to proper economic incentives, the industry must have an adequate supply of manpower and of basic materials needed for drilling wells and plant construction. This, of course, means allocations of steel on an equitable basis and in sufficient quantities.

High levels of taxation which are now in effect and which substantially reduce the amount of funds made available from earnings for replacement and expansion projects have unquestionably impaired the vitality of the oil industry. The adverse effect of high taxes is accentuated by rising costs of finding new crude reserves and of plant construction, which tend to increase the amounts of new capital required. It is of utmost importance, therefore, that the destructive forces of increasing taxes and government interference in the operations of the industry should not be permitted to develop to the point where they would cripple the industry's effort and would thus endanger the adequacy of liquid fuels supply to our nation in case of emergency.

• •

COL. HARRY T. KLEIN
President, The Texas Company

A MAJOR problem facing the oil industry in 1952 involves the continued efficient development of foreign oil resources on a fair and equitable basis to all concerned. This is important not only to American oil companies, but also to our nation. American oil companies have made investments abroad with the reasonable expectation, based on written contracts, of earning a fair return on their investments. However, in the light of recent events in Iran, and earlier in Mexico, it is only natural that companies will become more cautious, perhaps even to the point of refraining from making such investments.

Col. Harry T. Klein

Fundamentally, there should be no difference between a contract with

a government and one with an individual, except that it might be expected that governments would be inclined to be even more punctilious than others in the observance of obligations. The sanctity of contracts is an issue which cannot be ignored by governments, any more than it can by individuals and companies. If the U. S. government would use its influence for morality in business, nationally and internationally, it could be a vital factor in restoring peace and decency to a turbulent world.

• •

T. S. PETERSEN

President,
Standard Oil Company of California

THE oil industry in the U. S., during the past six months, has had to go "all out" to help shoulder worldwide petroleum demands placed upon it by the shutdown of Iranian production. At a time when there was little reserve of either producing or refining capacity, or of transportation facilities, it was called upon to help make up a daily output of about ½ million barrels at least temporarily lost to the Western world. Through coordinated effort, and the cooperation of many individual companies, it has done this job well, and without serious inconvenience either to the public, or to the requirements of the military.

T. S. Petersen

It seems to me, therefore, that the oil industry's major problem, as it enters 1952, is that of assuring adequate supplies to meet current and future demand situations which may well arise under the extremely uncertain world conditions existing at this time. It must drive forward with a continuing program to develop a margin of reserve production, refining and transportation facilities.

Standing in opposition to this needed expansion are a variety of immediate obstacles beyond the scope of the industry's control. Foremost among these are a limited availability of steel, and a lead shortage which even now is affecting quality of motor gasolines. However, if the industry's essential requirements for scarce material are recognized and supplied, performance in the past should assure that the petroleum industry will meet the challenge of these conditions in 1952.

• •

S. A. SWENSRUD

President, Gulf Oil Corporation

ONE of the foremost problems in 1952 will be rising taxes and the consequent impact on the petroleum industry's financial position. Increased taxes will have adverse effects on ability and incentive for further expansion of facilities. This applies to both increased corporate and sales taxes.

The restrictive nature of direct corporate taxes is readily apparent, although the damaging effects of excessive sales taxes are frequently overlooked. High sales levies on finished products discourage consumption, and thereby limit the industry's growth potential.

S. A. Swensrud

Regarding current financial results, it must be remembered that profits which appear substantial on the surface are to a certain extent illusory. This is due, of course, to the current cost of replacing wornout equipment and depleted crude reserves at today's inflated prices. Consequently, if the industry is to look forward to a continuing expansion in product demand, together with the ability to meet it, it is essential that the sharp upward trend in both corporate taxes and in normal taxes on the sale of petroleum products be arrested.

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K. S. ADAMS

Chairman of the Board,

Phillips Petroleum Company

IN 1952, the oil industry must face two outstanding problems, the critical steel situation and the necessity for a crude oil price increase.

Since 1948, crude oil prices have dropped approximately 1 percent while the cost of iron and steel has gone up almost 20 percent. These figures do not include increased transportation and other additional costs the industry has been forced to pay that result in steel costing over 30 percent of the total investment in a well. Exploration and geological expenses also have become increasingly greater as deeper horizons and more distant and difficult areas are searched.

K. S. Adams

Approximately 50 percent of the petroleum industry's total expenditures are for iron and steel in one form or another. Also, steel products are increasingly difficult to obtain for expansion, maintenance and repairs.

The last general crude price increase occurred in 1947, four years ago. The oil industry appeared to fare somewhat better in 1951 than in 1950 because of greater crude production, small improvements in product prices, and a near-capacity utilization of all facilities. But it is estimated that 50 percent of the industry's present production comes from prewar discoveries. It follows that half of today's production is obtained from "higher cost" wells, drilled in the postwar period.

To replace this oil we must spend considerably more money than prewar, not only because wholesale dollars are worth only $0.43 today compared to their value in 1939, but because wells must be drilled deeper. Each time costs go up and the oil industry absorbs these costs, the price received for oil, in effect, declines. A proper price for crude oil is the best assurance of an adequate future supply.

Steel to Continue Scarce In Second Quarter

By ROBERT E. SPANN
WORLD OIL Staff

IN ANTICIPATION of record requirements of the petroleum industry in 1952, Petroleum Administration for Defense has raised its sights on a higher steel allocation for the second quarter.

PAD asked Defense Production Administration for a total of 2,414,917 tons of steel for domestic and foreign operations of U. S. petroleum companies, of which 2,141,988 tons were requested for the domestic industry. The quarterly request, the largest yet asked by PAD, represents an increase of 233,424 tons over the agency's bid for steel for the first quarter of 1952 and is equal to 706,417 tons more than was actually allocated for petroleum operations for the January-March period.

The actual allocation of steel to the petroleum industry for the first quarter of this year amounted to 77 percent of PAD's requests, and in view of several adverse factors in the 1952 steel situation it is expected the petroleum industry's claimant agency will experience much difficulty in getting a higher percentage allocation for second quarter operations. These factors include:

- Possibility of a strike of steel industry workers that would seriously endanger total steel availability for all of 1952 if the threatened walkout lasted for a prolonged period of time.
- The growing military appetite for steel that is expected to increase during each quarter of 1952 and reach a peak early in 1953.
- Continued serious shortages of steel scrap, a primary steel-making material. Collections of scrap normally are at the lowest during the winter months, and the effects will be felt in both the first and second quarters of this year.
- Increased needs for steel from other defense and defense-supporting industries which will rise in proportion to the increased military preparedness program.

IN LINE with expected record demand for oil and gas in 1952, the Petroleum Administration for Defense has requested for the second quarter of 1952 the highest allocation of steel it has ever asked. The request calls for 2,414,917 tons for domestic and foreign operations of U. S. companies, including 2,141,988 tons for domestic use. The total is 233,424 tons more than was requested for the first quarter of 1952 and 706,417 tons more than was actually allocated. The first quarter actual allocation was 77 percent of PAD's requests, and several adverse factors threaten difficulty in getting a second quarter allocation representing any higher proportion of the PAD request for that period.

In requesting steel for the second quarter, Petroleum Administrator Bruce K. Brown set a 1952 minimum drilling program of 45,000 new wells for the domestic industry, which would represent a slight increase over the record of more than 44,000 completions made in 1951. Brown said possibly 46,000 wells could be completed in 1952, based on the PAD programmed requirements, assuming large reductions will not be made in the industry's allocations and that actual delivery of allocated supplies this year will be better than was experienced in the last six months of 1951 under the Controlled Materials Plan.

Steel Plate Bid

Included in PAD's second quarter request for a total of 2,266,120 tons of carbon steel (2,010,963 for domestic use) is a bid for 813,946 tons of critically short steel plate (751,111 for the domestic industry). Of the total plate tonnage requested for the domestic industry, nearly all of which is used for making large-diameter line pipe, PAD proposed to allocate 339,500 tons for oil transportation (crude and products) and 274,777 tons for natural gas transmission and distribution systems. If this ratio is maintained in the final allocation of steel plate to the industry for the second quarter, PAD will be following through on its earlier announced promise to grant crude oil and refined product lines higher percentages of available plate than is planned for natural gas lines in the first half of 1952. In the final six months of 1951, PAD's desire to get essential natural gas lines completed to eastern areas before winter, led it to give natural gas transmission, distribution and gathering lines about two-thirds of the total oil and gas industry alloca-

First Half 1952 Oil Industry Steel Picture

	PAD REQUESTS FOR SECOND QUARTER				FIRST QUARTER	
	Domestic Industry	Canadian Operations	Other Foreign Operations	Total	Requested Tonnage	Actual Allocation
Total Tons	2,141,988	47,030	225,899	2,414,917	2,181,493	1,708,500
Carbon Steel	2,010,963	43,630	211,527	2,266,120	2,030,700	1,595,000
Alloy Steel	122,657	2,000	12,902	137,559	147,045	110,000
Stainless Steel	8,368	1,400	1,470	11,238	3,748	3,500

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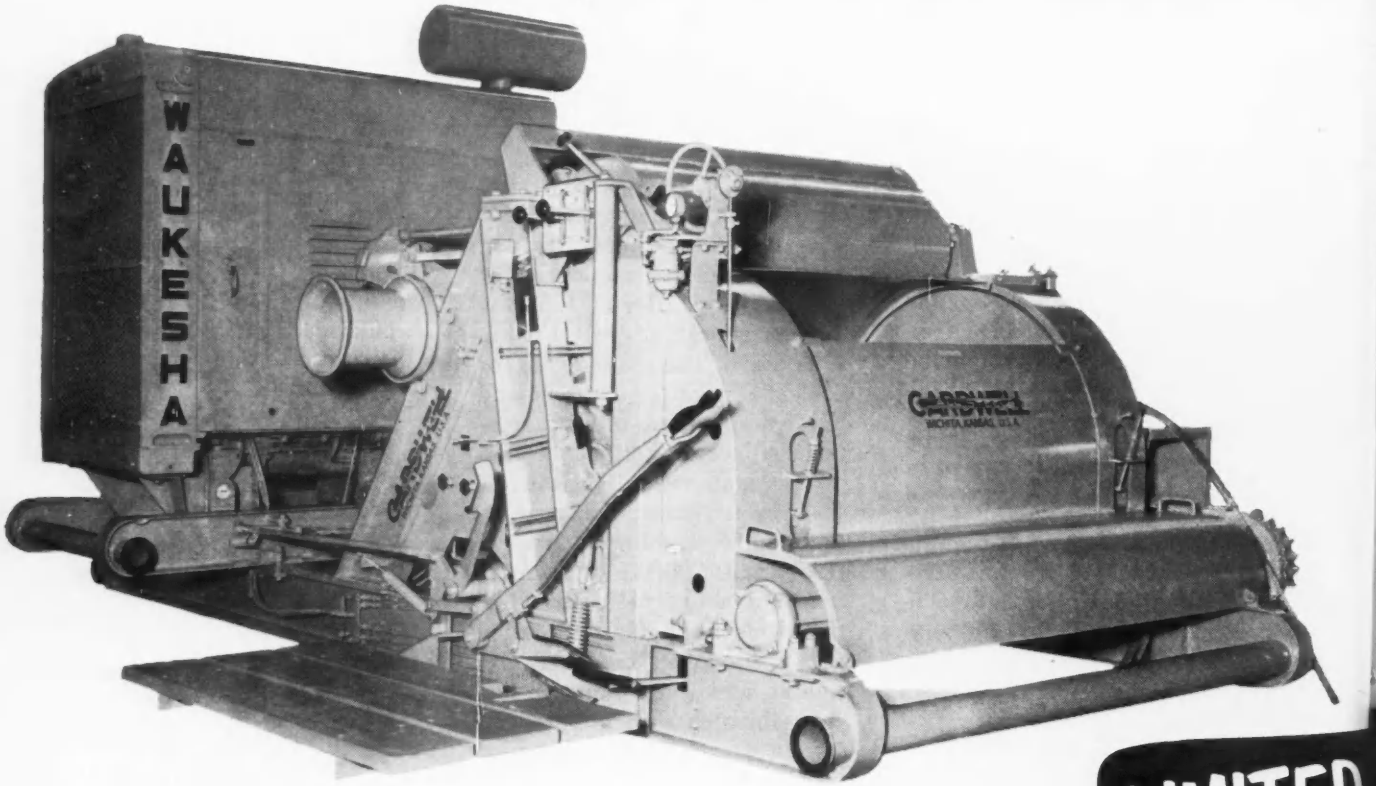

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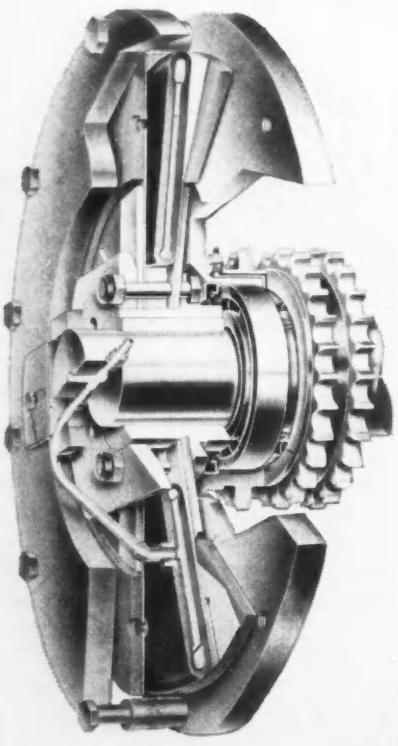

Model S, 4,500-Foot Draw Works

features... "Hi-Lo" drum drive, operated by "Flex-Disc" air friction clutches, makes it possible to double the line speed instantly without stopping the drum or block.

Cardwell five-speed and reverse transmission has even-ratio gear changes. This transmission, with its high torque capacity, makes possible the use of one large engine of high horsepower rating. Torque converter is available.

Rotary table drive is operated by an air friction clutch equipped with an air-operated rotary table brake.

Model S is available with the following engines for immediate delivery: Waukesha WAK, Waukesha WAKD, and General Motors 8103.

Cardwell "Flex-Disc" air friction clutches, standard equipment on Cardwell rigs, increase operating ease and speed. "Flex-Disc" air clutches are trouble-free, require no adjustment, are burn-proof and will last indefinitely without repairs.

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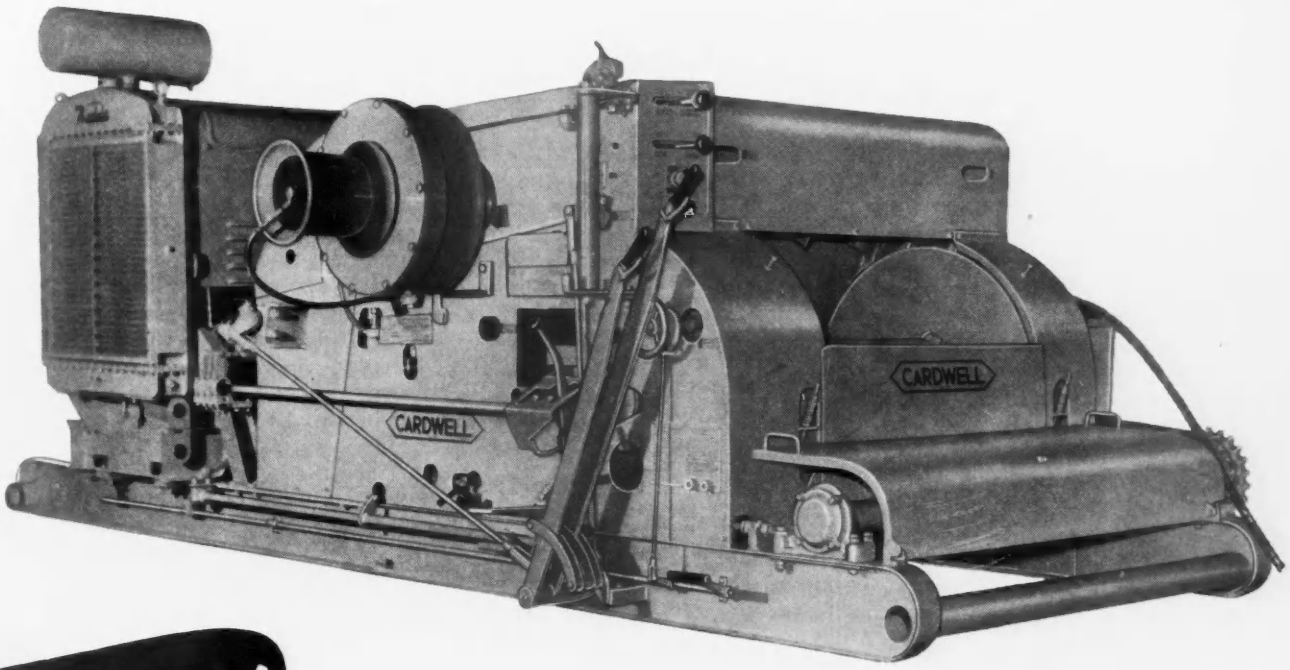

QUANTITY

Model L, 3,500-Foot Draw Works

features...Cardwell "Flex-Disc" air clutches, in the end of main drum and optional sand line drum, give fast, positive engagement when handling heavy hoisting loads.

"Hi-Lo" drum drive operated by "Flex-Disc" friction clutches, makes it easy to select either the high or low drum drive instantly.

Model L is available with either gear transmission or torque converter. Compact design and light weight (14,000 lbs.) make the Model L easy to move and rig-up,

Model L is now available for immediate delivery with the following engines: General Motors 6031C, General Motors 8107, Waukesha 145GK, and Waukesha 148DK.

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tion of approximately 1.6 million tons of line pipe of all sizes.

For the first quarter of this year crude oil and product lines received an allocation of 315,000 tons of line pipe (including all sizes) and natural gas lines were allocated 326,650 tons of pipe. Should the crude oil and product lines actually receive all of the first quarter allocation, approximately 451,800 tons of line pipe would be needed to complete all of the major construction projects that had been approved by PAD for priorities assistance in getting essential controlled materials before the end of 1951. Gas transmission projects that had been approved prior to the end of 1951 required a total of 915,460 tons of line pipe of which 324,650 tons were allocated for the first quarter, leaving a total of 590,810 tons of needed line pipe for completion.

PAD has indicated that such approved projects will be completed during 1952, and PAD would then be in a position to allocate line pipe to other highly essential projects on which construction has not started due to materials shortages.

Slippages in line pipe deliveries because of plate shortages, one of the essential finished steels required by military as well as nearly all heavy defense industries, continue to plague construction programs. National Production Authority recently stated there was urgent need to increase heavy steel plate production for approximately 200,000 tons a quarter to satisfy present indicated total demand. According to NPA, a substantial tonnage of authorized controlled materials orders for fourth quarter 1951 plate could not be placed with mills, which means a further drain on available producing facilities will be noted in the first and probably second quarters of 1952.

The petroleum industry in seeking priorities assistance in getting controlled materials is now subject to an extensively revised NPA order M-46, the basic order for controlled materials applicable to the oil and gas industry. The more important revision of the procedure for materials assistance, which was promulgated December 12, applies to applications for line pipe.

Revised Order

The revised order established three classes of line pipe requests:

- Those for line pipe to be used in large construction operations, which involve a total cost for controlled materials of $5000 or more.
- Those in which an operator's combined requirements for line pipe in any calendar quarter for maintenance, repair, operation, production and small construction total $5000 or more.
- Those in which an operator's combined requirements for line pipe for these purposes in any quarter total less than $5000.

Steel Requests for Second Quarter Domestic Oil and Gas Operations

Industry Branch	Total Steel Requested	*Plate Tonnage	*Other (Including Oil Country Tubular Goods)
Oil & Gas Production	510,750	4,700	506,050
Natural Gas Processing	78,776	13,680	65,096
Oil Transportation	551,050	339,500	211,550
Gas Transmission, Distr.	459,930	274,777	176,153
Refining	151,200	65,000	86,200
Marketing	3,450	1,400	2,050
Maintenance, repairs and Operating Supplies (MRO)	99,583	13,005	86,578
Oilfield Machinery and Equipment	165,224	39,449	125,775

*Included in plate tonnage is steel requested for large diameter line pipe. Steel requested for line pipe below 16-inch diameter is included in "Other" tonnage.

For large construction projects operators must, as in the past, file a form PAD-26, setting out the requirements. For other uses which will take more than a total of $5000 of line pipe in a quarter, a new form PAD-26LP must be used. For operations involving less than $5000 of line pipe in a quarter, either form PAD-26LP or delivery orders subject to PAD approval may be used. Regarding delivery orders that require PAD approval, the new revised order now exempts orders for controlled materials less than $100. Previously, approval of all orders amounting to $25 worth of controlled materials had to be submitted for PAD approval.

The order established a revised procedure for revalidating allotments for controlled materials that cannot be placed in the quarter for which they are issued. Delivery orders that have not been filled by the last day of the quarter for which the allotment was made now becomes invalid. Revalidation of unfilled delivery orders must be requested by operators prior to the 15th day after the close of the quarter for which the unfilled allotment was made, except that no revalidation can be requested for oil well tubing, casing or drill pipe that was not filled in the indicated quarter.

The quota of maintenance, repair and operating supplies (MRO) that is allowed operators is increased to 120 percent of the material used for these operations in 1950. Formerly, the quota of MRO supplies was limited to 100 percent.

PAD Forms

The revised M-46 order also establishes new filing dates for various forms. The current PAD forms to be used and filing dates are:

Form PAD-15 (application for emergency use of tubing and casing) may be filed as the emergency arises.

Form PAD-17 (application for casing and tubing needed for regularly programmed drilling) must be filed on or before the first day of the third month preceding the calendar quarter in which delivery is required.

Form PAD-17DP (covering regularly programmed needs for drill pipe) must be filed on or before the 15th day of the fourth month preceding the calendar quarter in which delivery is required.

Form PAD-17DPE (emergency requests for drill pipe) may be filed when an emergency arises.

Form PAD-26 (covers materials for large construction projects) must be filed as far as possible in advance of the time priorities assistance is needed.

Form PAD-26LP (the new line pipe form) must be filed on or before the first day of the third month preceding the calendar quarter in which delivery is required.

Need for New Oil Reserves Poses

EXPLORATION CHALLENGE

By DR. B. B. WEATHERBY, Vice President

Amerada Petroleum Corporation, Tulsa

THE problem of keeping this country adequately supplied with oil and gas is one of tremendous proportions and in its broadest aspect devolves primarily on the exploration branch of the oil industry, and more specifically upon the geologist and geophysicist. To present a picture of the increasing demands for oil and gas, it is significant to note that in 1950, for the first time, more than one-half—54 percent to be exact—of the energy requirements of our nation's dynamic economy were supplied by oil and gas. Recent daily crude oil production rates indicate that more than 2 billion barrels will be produced in 1952 to meet the demands of industry.

Accustomed as we are these days in dealing with "billions," it is still difficult for us to comprehend the magnitude of such figures. However, one or two examples may show how much oil we are using and how much we must find if we are not to fall in arrears.

Western Canada, particularly Alberta, came into the limelight a few years ago because of the discovery of the two large reef oil fields at Redwater and Leduc. More recently a number of smaller fields have been found there as a result of an aggressive exploratory campaign. In spite of the large size of Alberta's known reserves, they add up to about the same as the amount of oil consumed in the U. S. every six months.

The huge East Texas field, by far the largest found in the U. S. to date, except perhaps the comparatively new Spraberry accumulation in West Texas, has produced in over 20 years about the same amount of oil as is needed in a little over a year at our present rate of consumption.

The problem of finding 2 billion barrels of oil a year is a hard one to solve, since it occurs at a time when oil is becoming increasingly difficult to locate. The difficulty is further aggravated by the fact that even greater amounts may be needed in the future. It was stated at the last annual meeting of the American Petroleum Institute in Chicago that world production rates in the next ten years will have to be increased some 35 percent. Up to now, the U. S. has been producing nearly two-thirds of the world's oil from one-third of the world's petroleum reserves. In mid-1950 our excess efficient productive capacity was approximately 1 million barrels per day, but this has dwindled to about one-half this amount at the present time. Furthermore, the international picture may make it necessary for the American oil industry to increase its producing capacity beyond the figures previously mentioned. There can be no doubt of the immensity of our problem and of its increasing complexity.

VASTNESS of the present job of finding great amounts of new oil reserves each year is shown by the fact that all reserves so far proven in Western Canada equal only about the same amount of oil as that consumed in the U. S. every six months. The author recommends less emphasis on prospecting in areas already densely drilled and more emphasis on prospecting in sparsely developed regions that have important possibilities. More effective geophysical work should be attempted through better interpretation, more skillful use of instruments, and better trained personnel. Through maximum efficiency, substantial savings can be achieved in the cost of geophysical surveys, and the savings that are made can finance additional prospecting and additional discoveries.

In his annual review of wildcat drilling, Dr. F. H. Lahee[1] points out that of about 5000 wildcats drilled in 1951 on technical information, only one out of eight was successful. This low average is an index of the difficulty of finding new oil and at the same time is a measure of the opportunity for improvement. The small size of the accumulations in many of these discoveries has also been emphasized. This suggests that one approach to our problem would be to allocate a larger percentage of our exploratory activity to those areas where the density of geophysical coverage and the density of wells is

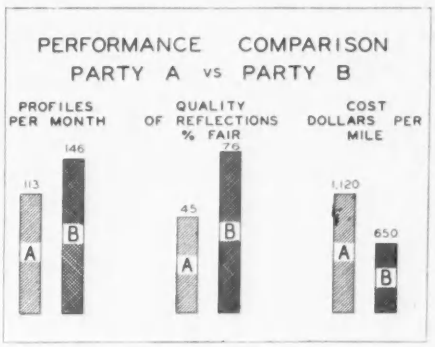


FIGURE 1

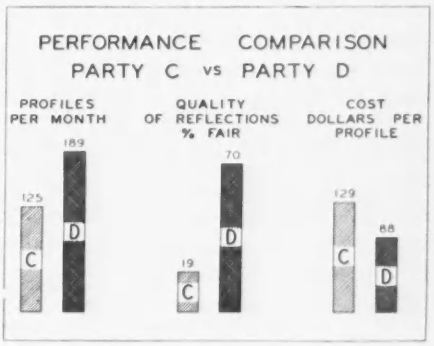


FIGURE 2

sufficiently low to give a better chance for the discovery of oil fields of substantial proportions.

In the last few years there have been times when there were from 80 to 100 crews in the coastal areas of Texas and Louisiana. There were also quite a number in both the San Joaquin Valley of California and Central Oklahoma. Those crews were working in areas in which there had been sufficient previous shooting to cover them thoroughly from 20 to 50 times. It is these programs of some years ago that are responsible for the present day discoveries, since an average lag of about three years exists between the initiation of an exploratory campaign and the discovery of oil as a result of it. In addition to the heavy seismic coverage, there was a sufficient density of wells in a good part of those areas virtually to preclude the existence of any very substantial field.

If the emphasis is to be placed on larger discoveries then it will be necessary to curtail activities in those densely shot and densely drilled areas, and to move out to the more hazardous but potentially more profitable provinces which are relatively undeveloped. There is a substantial number of areas with thick sedimentary columns of marine origin where little prospecting has been carried on.[2] These more or less attractive areas extend from the Florida peninsula on the southeast, to Nevada and even Washington on the northwest. Recent developments in the Williston Basin suggest that a new petroliferous province has been found as a result of prospecting in such areas as this. In addition, there are a substantial number of relatively small intermontaine basins or valleys which have petroliferous possibilities but which have seen little or no exploratory activity. For instance, prospecting in the Cuyama Valley in California resulted in a substantial discovery not long ago.

Considerable responsibility for the success of finding new reserves rests upon the shoulders of supervisors, party chiefs, observers and computers, who are directly involved in the operation of more than 500 seismic crews, about 60 percent of which are operated by the contracting geophysical companies. All must face the problem and do their best to meet it.

Re-allocation of crews is not the only solution, although a careful study of this phase of geophysical operations will certainly contribute toward the desired end. One line of attack would be the application of a new prospecting tool, but to the writer's knowledge, there is no new method that has demonstrated its ability to make significant contributions to the search for new reserves.

Lacking such a revolutionary tool, the geophysicist must apply the tools in hand in the most effective manner. Therein lies the most promising approach toward a solution of the problem. We must see to it that more efficient use be made of existing seismic methods and crews. A considerable part of our exploratory program is being conducted in an intelligent, business-like, and efficient manner by competent and serious-minded men. Nevertheless, a frank evaluation of geophysical activities leaves no doubt that there is considerable room for improvement from the standpoints of instrumentation, interpretation and economy.

The following examples indicate some surprising differences in the quantity, quality, and unit costs of work performed by different crews in the same area. Usually it is difficult to make an entirely fair comparison because of differences in weather, topography and surface conditions, as well as variations in reflection quality, even though the areas of comparison are adjacent to each other. In the comparisons presented here, the time of year and weather conditions were essentially the same and the areas were identical.

Figure 1 shows a comparison between party "A" and party "B." The bars at the left are scaled to represent the average number of profiles shot per month, 113 for party "A" and 146 for party "B." The bars in the center indicate that 45 percent of those on the records of party "B" were graded fair or good by the same standard. The bars at the right show that the unit cost of party "A" was $1120 per mile compared to $650 per mile for party "B." On a prospect that took 1½ years to shoot, the saving that could have been effected by the use of party "B" rather than party "A" would have been more than $100,000, not to mention the great advantage of the higher quality data.

Figure 2 shows the performance comparison of parties "C" and "D," operating in a different area from the first example, but again under identical conditions. The bars at the left show the average number of profiles per month, 125 for party "C" compared to 189 for party "D"; the bars in the middle show 19 percent of the key reflections were graded fair or good on party "C," compared to 70 percent on party "D"; the bars on the right indicate the unit cost of party "C" was $129 per profile, compared to $88 per profile for party "D." In this case the difference in reflection quality was so great that the work of party "C" was repeated, to get a dependable map.

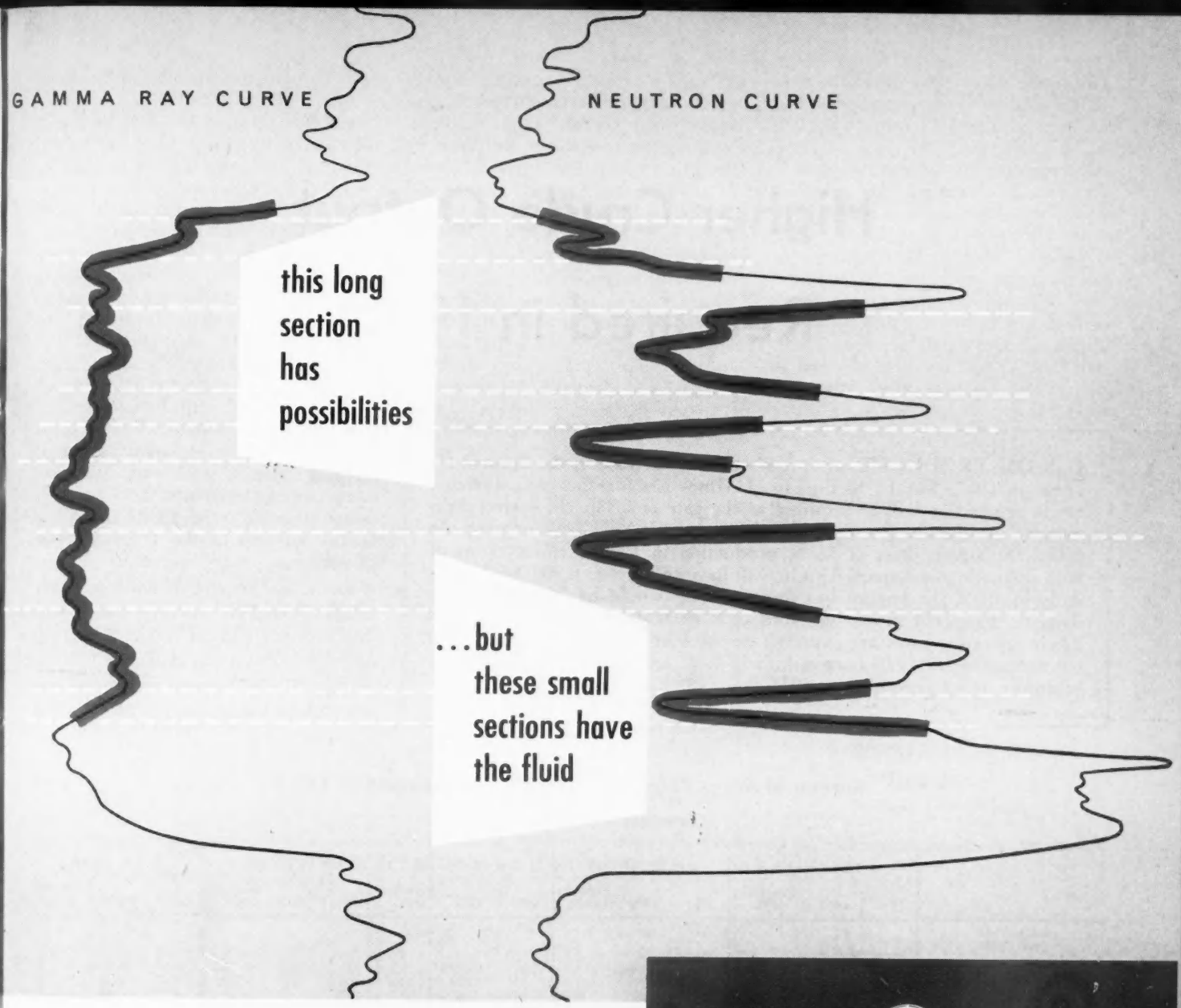
Additional comparisons of this kind have been made with similar results, but these two examples suffice to show the wide variations in efficiency that do exist.

The indices used in these comparisons do not give the whole story of the effectiveness of a seismic program. Differences in instruments, in instrument operating practice, and variations in field procedure are factors

■ CONTINUED ON PAGE 50

About the Author

DR. B. B. WEATHERBY received his M.S. degree from Haverford College in 1922 and his Ph.D. from the University of Pennsylvania in 1929. From 1925-27 he was chief of a field party for the Geophysical Research Corporation. After teaching physics at the University of Pennsylvania, returned to the company as division chief and became president in 1933, a position he still holds. He is also a vice president of Amerada Petroleum Corporation. During World War II Dr. Weatherby was chairman of the War Efforts Advisory Committee of the Society of Exploration Geophysicists; consultant for the Office of Scientific Research and Development; chairman of the Manpower Subcommittee of the District 2 Production Committee of the Petroleum Industry War Council; and member of the National Service Committee of the American Association of Petroleum Geologists. He holds several patents on inventions which have contributed to the science of geophysics and is the author of many published articles on the subject.



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Higher Crude Output Required in 1952

U. S. OIL PRODUCERS are promised some increase in the demand for crude in 1952. The U. S. Bureau of Mines has forecast that domestic crude production will be required at the rate of 6,336,000 barrels daily average in 1952, an increase of 185,000 barrels or 3 percent over the 6,151,000 barrels daily of U. S. production in 1951. Refinery runs of both domestic and imported crude will have to average 6,760,000 barrels daily in 1952, the bureau has forecast. This would be 260,000 barrels daily or 4 percent more than runs of 6,500,000 barrels daily in 1951. These operating rates are expected on the basis of total demand for all oils averaging 7,841,000 barrels daily in 1952, an increase of 378,000 barrels daily or 5.1 percent over 1951.

TOTAL demand for all oils, domestic crude production, runs to refineries, and imports of petroleum into the U. S. will reach new highs in 1952, according to the forecast of the U. S. Bureau of Mines.

U. S. and export demand will average 7,841,000 barrels daily this year, an increase of 378,000 barrels, or 5.1 percent, over 1951, the bureau estimates—or the smallest annual rise in anticipated requirements in two

Bureau of Mines Forecast of Supply and Demand in 1952

(Thousands of Barrels Daily Average)

	1st QUARTER			2nd QUARTER			3rd QUARTER			4th QUARTER			FULL YEAR		
	1951	1952	Percent Diff.	1951	1952	Percent Diff.	1951	1952	Percent Diff.	1951	1952	Percent Diff.	1951	1952	Percent Diff.
DEMAND															
All Oils															
Total Demand	7737	8187	+ 5.8	7063	7462	+ 5.6	7169	7478	+ 4.3	7886	8239	+ 4.5	7463	7841	+ 5.1
Domestic	7448	7780	+ 4.5	6655	7099	+ 6.7	6618	7228	+ 9.2	7427	8022	+ 8.0	7036	7533	+ 7.1
Export	289	407	+ 40.8	408	363	—11.0	551	250	—54.6	459	217	—52.7	427	308	—27.9
Crude Oil	89	55	— 38.2	85	55	—35.3	75	43	—42.7	59	43	—27.1	76	49	—35.5
Products	200	352	+ 76.0	323	308	— 4.7	476	207	—56.5	400	174	—56.5	351	259	—26.2
Motor Fuel															
Total Demand	2732	2923	+ 7.0	3210	3484	+ 8.5	3341	3565	+ 6.7	3127	3304	+ 5.7	3104	3320	+ 7.0
Domestic	2668	2824	+ 5.8	3117	3396	+ 9.0	3190	3500	+ 9.7	2997	3250	+ 8.4	2995	3243	+ 8.2
Export	64	99	+ 54.7	93	88	— 5.4	151	65	—60.0	130	54	—58.5	109	77	—29.4
Residual															
Total Demand	1826	1813	— 0.7	1543	1505	— 2.5	1413	1457	+ 3.1	1666	1728	+ 3.7	1611	1626	+ 0.9
Domestic	1788	1736	— 2.9	1463	1440	— 1.6	1298	1413	+ 8.9	1572	1696	+ 7.9	1529	1571	+ 2.7
Export	38	77	+ 102.6	80	65	—18.8	115	44	—61.7	94	32	—66.0	82	55	—32.9
Distillate															
Total Demand	1724	1879	+ 9.0	956	1055	+10.4	951	989	+ 4.0	1514	1609	+ 6.3	1285	1382	+ 7.5
Domestic	1693	1802	+ 6.4	900	989	+ 9.9	856	957	+11.8	1445	1587	+ 9.8	1222	1333	+ 9.1
Export	31	77	+ 148.4	56	66	+17.9	95	32	—66.3	69	22	—68.1	63	49	—22.2
Kerosine															
Total Demand	474	517	+ 9.1	236	253	+ 7.2	247	250	+ 1.2	470	478	+ 1.7	356	374	+ 5.1
Domestic	469	489	+ 4.3	221	236	+ 6.8	213	244	+14.6	441	473	+ 7.3	335	361	+ 7.8
Export	5	28	+ 460.0	15	17	+13.3	34	6	—82.4	29	5	—82.8	21	13	—38.1
Other Oils															
Total Demand	981	1055	+ 7.5	1118	1165	+ 4.2	1217	1217	.....	1109	1120	+ 0.9	1107	1139	+ 2.9
Domestic Demand	830	929	+ 11.9	954	1038	+ 8.8	1061	1114	+ 5.0	972	1016	+ 4.5	955	1025	+ 7.3
Export	151	126	— 16.6	164	127	—22.6	156	103	—34.0	137	104	—24.1	152	114	—25.0
STOCK CHANGES															
Total, All Oils	—283	—439	.....	+497	+307	.....	+361	+392	.....	—206	—260	.....	+ 93	0	.....
*Crude Oil	—163	0	.....	+158	0	.....	+ 73	0	.....	+ 50	0	.....	+ 30	0	.....
Products	—121	—439	.....	+339	+307	.....	+288	+392	.....	—256	—260	.....	+ 63	0	.....
NEW SUPPLY															
Total New Supply	7454	7748	+ 3.9	7560	7769	+ 2.8	7530	7870	+ 4.5	7680	7979	+ 3.9	7556	7841	+ 3.8
Domestic Production	6528	6880	+ 5.4	6684	6901	+ 3.2	6759	6957	+ 2.9	6863	6979	+ 1.7	6710	6929	+ 3.3
Crude Oil	5964	6286	+ 5.4	6142	6319	+ 2.9	6211	6370	+ 2.6	6280	6370	+ 1.4	6151	6336	+ 3.0
Other Oils	564	594	+ 5.3	542	582	+ 7.4	548	587	+ 7.1	583	609	+ 4.5	559	593	+ 6.1
Imports	926	868	— 6.3	876	868	— 0.9	771	913	+18.4	816	1000	+22.5	846	912	+ 7.8
Crude Oil	484	494	+ 2.1	530	516	— 2.7	525	543	+ 3.4	477	565	+18.4	505	529	+ 4.8
Products	442	374	— 15.4	346	352	+ 1.7	246	370	+50.4	339	435	+28.3	341	383	+12.3
Runs to Stills	6492	6680	+ 2.9	6398	6730	+ 5.2	6519	6800	+ 4.3	6585	6830	+ 3.7	6500	6760	+ 4.0
†Domestic Crude Demand	6106	6286	+ 2.9	6004	6319	+ 5.2	6128	6370	+ 3.9	6237	6370	+ 2.1	6119	6336	+ 3.5

* Domestic and Foreign. † Domestic production plus or minus withdrawal or addition to stocks of domestic crude.

years. Total demand for all 1951 was placed at 7,463,000 barrels daily, a jump of 663,000 barrels, or 9.7 percent, over 1950. Domestic demand for all oils in 1952 is expected to rise to a daily average rate of 7,533,000 barrels, an increase of 7.4 percent over 1951. But an anticipated decline in export demand for U. S. petroleum to 308,000 barrels a day this year, 27.6 percent under the average of 1951, will be an offsetting factor.

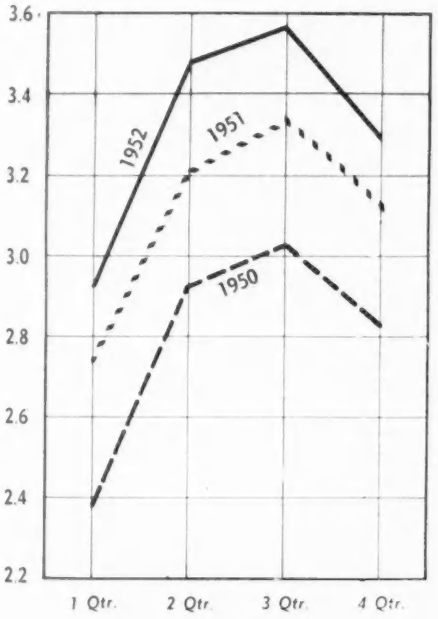
The Bureau of Mines forecast of total demand for all oils is 66,000 barrels daily higher than the estimated average for 1952 of 7,775,000 barrels a day made earlier by the program division of the Petroleum Administration for Defense and the Economics Committee of the Independent Petroleum Association of America.

The 1952 forecast, the bureau stated, is based primarily on the trends of domestic demand by products, assuming an ample supply of oil for all purposes. Increased military requirements in 1952, it was stated, involve primarily aviation gasoline and jet fuel blended from gasoline and distillate. It is also assumed in the forecast that exports of refined products will continue high during the first part of the year and drop sharply in the final six months, while total imports will remain relatively low in the first part of 1952 followed by a substantial upward trend in the last half. Total imports for all of 1952 are estimated at a new high of 912,000 barrels a day, 7.8 percent above the 1951 rate. Crude imports are expected to rise 4.8 percent over 1951 to an average of 529,000 barrels a day, while imports of refined products, consisting mostly of residual fuel, are placed at an average rate of 383,000 barrels, up 12.3 percent over last year.

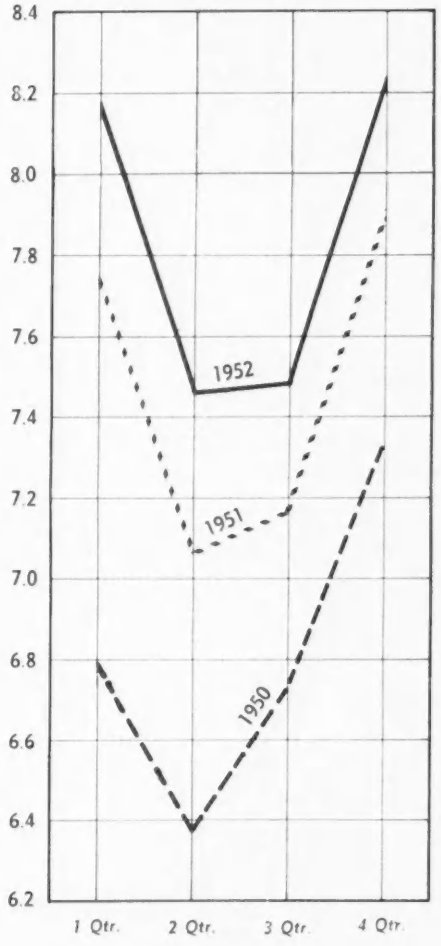
Due to problems of transportation facilities and refinery capacity, the bureau said it is assumed that operations should be near capacity levels in the first half of 1952 to leave a "reasonable" flexibility to meet any possible later requirements. The forecast anticipates net withdrawals from total inventories in the first six months of the year will average 132,000 barrels daily, to be evenly offset by net additions in the final six months, leaving no changes in total stock positions for the full year. Total stocks increased by an estimated 34 million barrels in 1951, or a daily average gain of 93,000 barrels.

To meet the anticipated demand, the bureau forecasts domestic crude production will have to average 6,336,000 barrels daily for the year, an increase of 3.5 percent over 1951 demand for U. S. crude, and refinery runs of both domestic and imported crude will have to average 6,760,000

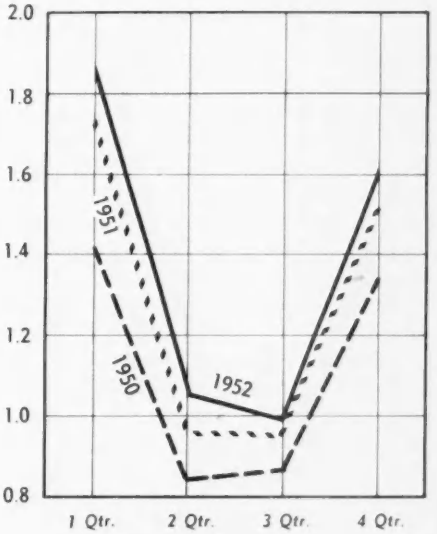
MOTOR FUEL
Total Demand
(Millions of Barrels Daily)



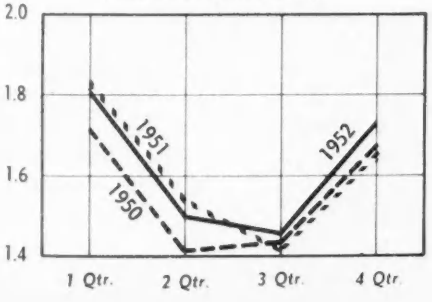
ALL OILS
Total Demand
(Millions of Barrels Daily)



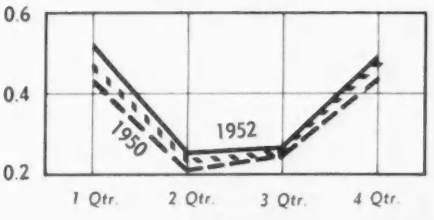
DISTILLATE FUEL OIL
Total Demand
(Millions of Barrels Daily)



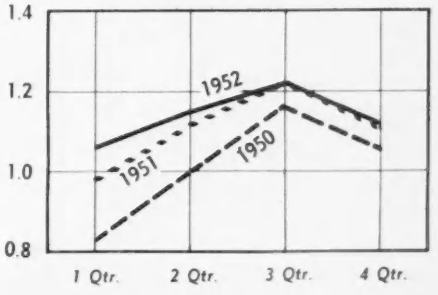
RESIDUAL FUEL OIL
Total Demand
(Millions of Barrels Daily)



KEROSINE
Total Demand
(Millions of Barrels Daily)



LUBE, ASPHALT, MISC. OILS
Total Demand
(Millions of Barrels Daily)



barrels a day, or 4 percent higher than the 1951 rate of throughput.

Total new supply is forecast at a new peak of 7,841,000 barrels daily, up 3.8 percent over the total amount available in 1951. The new supply for 1952, according to the bureau, will consist of a record daily average crude production of 6,336,000 barrels, 593,000 barrels a day of liquid hydrocarbons other than crude, and total imports at a new high of 912,000 barrels a day. This compares with PAD's estimate of total new supply of 7,762,000 barrels daily in 1952, broken down as consisting of 6,290,000 barrels daily of domestic crude production, 575,000 barrels a day of other petroleum liquids, and 868,000 barrels daily of total imports. PAD's estimate of required runs to stills amounted to a daily average of 6,680,000 barrels for all of 1952. IPAA forecast the required refinery throughput would average 6,721,000 barrels a day.

Peak total demand in 1952, according to the bureau's estimates, will be reached in the fourth quarter of the year, averaging 8,239,000 barrels a day and 52,000 barrels a day higher than anticipated demand for the first quarter of 1952. Both the PAD and IPAA forecasts were in contrast with this expected trend in demand during the year. PAD estimated peak demand will be reached in the first three months of 1952 at an average of 8,328,000 barrels a day and requirements in the fourth quarter will be 243,000 barrels a day below that peak. IPAA, forecasting a first quarter demand of 8,170,000 barrels daily, predicted demand in the final three months of 1952 will be 30,000 barrels daily less than the January-March daily average requirements.

Daily average demand for all oils for 1951 amounted to 7,463,000 barrels, according to the bureau's calculations, while IPAA estimated last year's requirements at 7,465,000 barrels a day and PAD placed 1951 demand at 7,445,000 barrels daily.

Domestic crude demand this year, according to the bureau, will range from a daily average of 6,286,000 barrels in the first quarter, 6,319,000 barrels in the second three months, and increasing to 6,370,000 barrels for the last six months of the year. Crude runs to stills are expected to range from 6,680,000 barrels daily in the first quarter, rising steadily to 6,830,000 barrels a day in the October-December period.

Total exports, which in 1951 averaged 427,000 barrels a day, or more than 40 percent over the 1950 rate, are expected to average 407,000 barrels a day during the first quarter, or 40.8 percent over a year earlier, but are expected to decline steadily to 217,000 barrels a day by the final three months of the year. Crude exports, which in 1951 dropped 20 percent from 1950 due largely to completion of the Canadian pipe line from Alberta to Lake Superior, will continue downward in 1952, averaging 49,000 barrels a day for the year, or 35.5 percent less than last year. Demand for U. S. refined products in world markets in the first quarter of this year will continue at a high rate, averaging 352,000 barrels daily, or 76 percent above the like 1951 quarter, to fill the gap created by the closing last July of the Abadan refinery. But even assuming Iran's 550,000 barrels daily refinery continues closed to world markets, the expected help from additional refining capacity being rapidly completed primarily in Western Europe will result in a diminishing need for U. S. refined products. By the fourth quarter of 1952, export products demand is expected to be no greater than 174,000 barrels daily, compared with demand of 400,000 barrels a day in the fourth quarter of 1951.

The sharpest percentage increases in product demand anticipated for 1952 is for an expansion of 7.5 percent in total distillate demand to 1,382,000 barrels daily, with domestic distillate requirements expected to expand 9.1 percent to a daily average of 1,333,000 barrels daily, and exports to drop 22.2 percent to 49,000 barrels a day. Motor fuel requirements this year are expected to average 3,320,000 barrels a day, up 7.0 percent over 1951. Domestic demand is estimated at 3,243,000 barrels daily, an increase of 8.2 percent, while export needs are expected to decline 29.4 percent to an average of 77,000 barrels a day. Military requirements for aviation gasoline and jet fuels figure in the higher domestic demand estimates for motor fuel and distillate.

Total demand for residual this year is expected to expand about 1 percent over 1951, with the domestic requirements placed at 2.7 percent larger and the export needs at 32.9 percent less. Domestic demand for kerosine is estimated at 7.8 percent above the 1951 requirements, but an anticipated 38.1 percent drop in export demand will limit the total requirements to 5.1 percent above last year. Total demand for other products is estimated at 2.9 percent greater than 1951, with domestic demand rising 7.3 percent and export requirements falling 25 percent.

Exploration Challenge Posed

• CONTINUED FROM PAGE 46

which will influence these indices directly. But the effectiveness of a particular seismic program also depends upon its relationship to its geological setting, on the interpretation of the seismic data, and the integration of the data with other geological information before the final evaluation is made.

A word about instruments and their operation. Over the years, seismic instruments have been developed to a high degree of efficiency, and are now more rugged so that they can withstand continuous mechanical shocks and operate under wide variations in temperature and humidity. Unfortunately, the advanced state of instrumentation has not reduced the requirement for skilled operators. Since more variables are under control, more skill is necessary in manipulation, if the best possible record is to be obtained at each location. Perhaps some day the theory and operation of seismic instruments will be reduced to very simple terms; but until then, the men who are responsible for the operation of the instruments should have considerable training and experience if they are to obtain the best results of which the instruments are capable. Most of the mistakes with regard to instruments and their operation can be corrected before they reach substantial proportions by a careful and regular check of the instruments, made by an operator with sufficient knowledge of their action to be able to spot and correct difficulties as soon as they develop.

Much has been said about the relation between geology and geophysics, and more probably needs to be said in an effort to increase the effectiveness of our exploration campaigns. In the writer's opinion, there is a fairly definite point at which the responsibility of the geophysicist ends and that of the geologist begins, and there should not be too much overlap.

A great deal of oil has been found by drilling on surface and near-surface structures, and this method of prospecting has been rejuvenated by photo-geology with some success. As might be expected, some dry holes have been drilled in recent years on Tertiary surface structures in the Rocky Mountain area. Subsequent to drilling the dry hole, some of these structures have been shot, with the result that no structure was found at depth. This suggests, of course, that the shooting should have preceded the

drilling of the well. There are some surface structures having beautiful exposures of rim rock older than Tertiary that have been developed into substantial oil fields from drilling the surface closure. Examples of this type are Oregon Basin and Elk Basin.

There are other surface structures that appear to be condemned by drilling. These should be carefully shot to see if the dry holes are on or near the top of deeper structure, for there may be considerable assymmetry and a very appreciable shift of structure with depth. Conversely, an absence of structure in these surface beds does not necessarily mean that there is no deeper structure below. There are considerable areas overlain with badly crumpled and faulted surface beds which may or may not reflect the conditions of the deeper beds. At depth, there may be a much simpler configuration of the strata, and consequently such areas are worthy of sufficient exploration to find out the true subsurface conditions. The foregoing remarks are presented to call attention only to the relation of surface geology to seismic programs.

In conclusion the writer wishes to emphasize that most of the weaknesses in instrument operation, field procedure, and handling of data are due to inadequately trained personnel. The shortage of trained manpower may be explained by the fact that exploration has expanded more rapidly than men have been trained. The general quality of seismic work will improve when competent supervisors are prompt in correcting weaknesses that crop up in the field; when party chiefs and observers not only understand the operation of the instruments but also the way to use them to the greatest advantage; when party chiefs and computers are interpreting seismic data accurately and thoroughly because they are aware of all the implications of the data; and when all of these men have been briefed on the geology of the area under investigation. Then the geophysicist will be meeting the challenge of finding 2 billion barrels of oil a year most effectively and at the greatest profit to himself and the industry he serves.

REFERENCES

[1] Dr. Frederick A. Lahee, "Exploratory Drilling in 1950," Vol. 35, No. 6, June, 1951, Bulletin of the American Association of Petroleum Geologists.

[2] "Possible Future Petroleum Provinces of North America," Vol. 35, No. 2, February, 1951, Bulletin of the American Association of Petroleum Geologists.

ACKNOWLEDGMENT

Prepared for WORLD OIL from a paper: "Some Uses and Abuses of the Seismic Method," presented by the author at the fifth annual Midwestern meeting of the Society of Exploration Geophysicists, Dallas, and with the permission of SEG.

Water-Flooding Trend Shown In Mines Bureau Report

A BUREAU of Mines report covering a survey of oil production in Oklahoma by water flooding emphasizes a trend in oil production. Confronted by increasing difficulty of finding new reserves, oil operators, large and small, are now scouring the country for depleted oil properties suitable for water flooding.

The report points out that increasing demands for petroleum and steadily rising costs of discovering and developing new oil fields emphasize the importance of increasing the recovery of oil from known petroleum reserves. Water flooding is a valuable conservation measure, not only preventing premature abandonment of stripper leases, but also reviving interest in many areas previously abandoned.

However, every depleted or abandoned oil field is not necessarily a prospect for successful water flooding. During the past few years inerperienced oil men—inexperienced, that is, in water flooding—have lost heavily on water-flooding ventures. In eastern Kansas and northeastern Oklahoma, two of the most active areas from the standpoint of water flooding, there are many depleted and abandoned fields, but all are not to be considered good water-flooding prospects. Bureau of Mines studies as well as studies by the U. S. Geological Survey stress this point. There are many factors which must be considered in water flooding in order to achieve a profitable operation. Primarily, the operator, before venturing into this business, should have complete engineering reports and core analyses. Viscosity of the oil, porosity of the formation to be flooded, estimated oil recovery per acre, and availability of water for injection purposes are some of the principal factors that must be considered and evaluated before an operator spends his money on a water flood.

Fortunately for the industry, major companies are devoting considerable money and attention to secondary recovery, and especially to water flooding. These efforts are paying off. In many old fields the search is going ahead for suitable properties, and landowners are again experiencing the happy feeling which goes with the receipt of bonus payments for acreage and oil royalty checks.

In the Bureau of Mines report on Oklahoma water flooding, the authors point out that this method of recovering additional oil from partly depleted oil-bearing formations was first tried in 1931 and was confined to the area of shallow Bartlesville-sand formations in Nowata and Rogers counties, where many of the projects were outstandingly successful. The results of these operations stimulated activities in other pools in Oklahoma, and by the end of 1949, water flooding had been tried in 25 of the 49 oil-producing counties in the state. Approximately 33 million barrels of oil, or 1806 barrels per acre, had been recovered by December 31, 1949, from 18,221 productive acres included in the 162 active and abandoned projects in Oklahoma, by injection of approximately 449 million barrels of water.

However, all water-flooding projects are not necessarily successful, nor are the oil deposits' reaction to the water pressure predictable as regards time or quantity of oil recovery. Sometimes the reaction is within a few days. At one project the injection of 368,177 barrels of water during nearly six years of operation resulted in the recovery of only 7888 barrels of oil from a 40-acre lease. Therefore, it behooves prospective flood operators to review carefully all facts and conditions before undertaking a water-flooding project.

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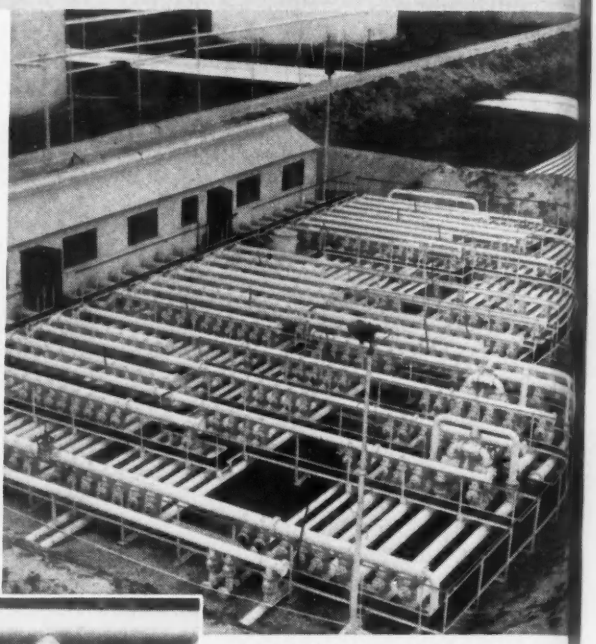
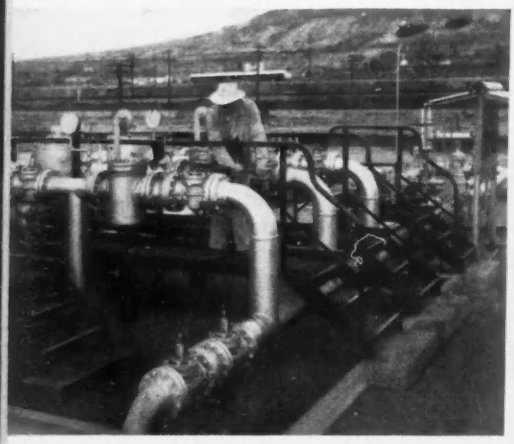
On GAS, CRUDE OIL *or*

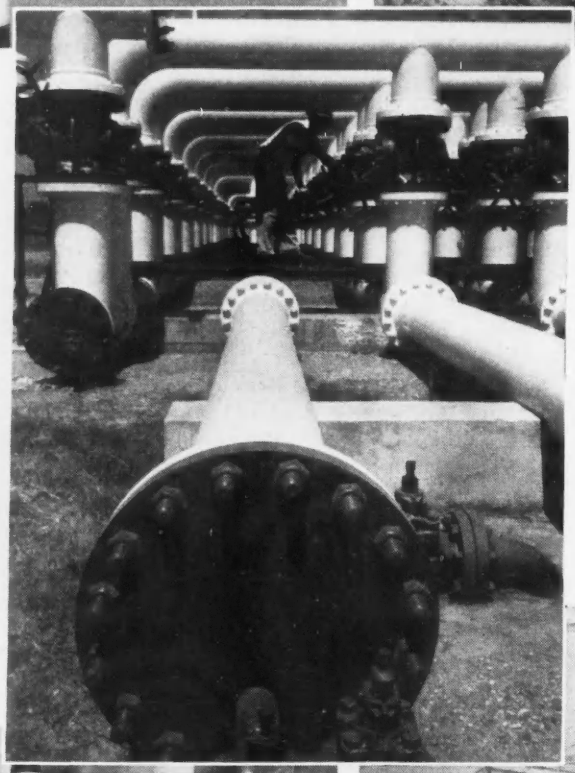
PRODUCTS LINE—Nordstrom valves and Rockwell built Pittsburgh Rotocycle meters at pumping station in Zionsville, Ind.



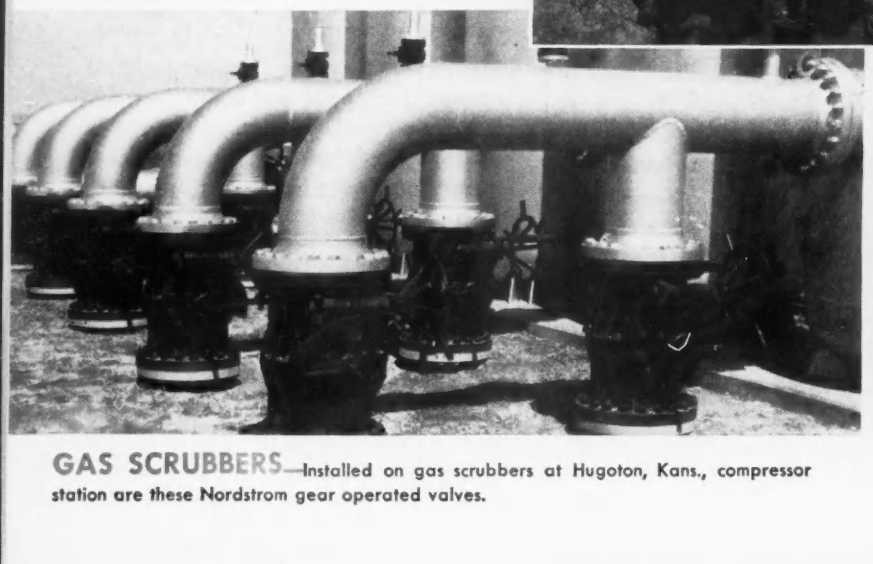
PRODUCTS TERMINAL—In East Chicago, Ind., is one of the largest products line terminals in the world, and in it there are over 1000 Nordstrom valves. This is one Nordstrom-equipped manifold.



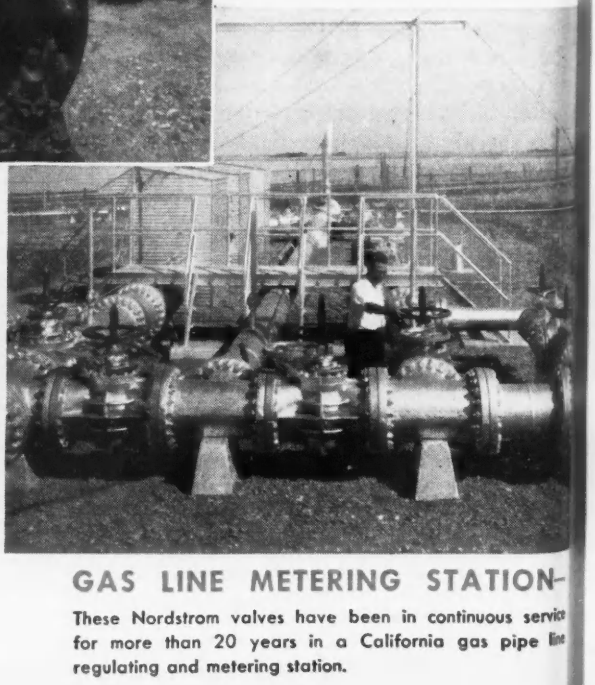
CRUDE OIL MANIFOLD—At the end of crude oil line from Rangely Field in Colorado to North Salt Lake, Utah, is this Nordstrom controlled manifold.



LOUISIANA CRUDE OIL LINES—Nordstrom gear operated valves guard this Louisiana crude oil pipe line manifold.

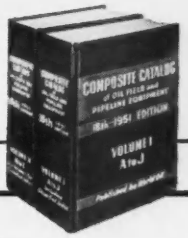


GAS SCRUBBERS—Installed on gas scrubbers at Hugoton, Kans., compressor station are these Nordstrom gear operated valves.



GAS LINE METERING STATION—These Nordstrom valves have been in continuous service for more than 20 years in a California gas pipe line regulating and metering station.

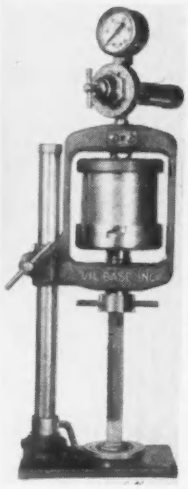
NEW AND IMPROVED EQUIPMENT



SUPPLEMENTING COMPOSITE CATALOG

KEEP INFORMED by requesting additional information on new equipment and services described on this and following pages. SAVE TIME by using one of the free and convenient Reader Service Postcards on opposite page. Circle number on card corresponding to the number listed at the end of each new equipment item on which you desire additional information.

Filter Press



This item supplements Oil Base, Inc., data on pages 3739-3746 of Composite Catalog, 18th Edition.

The OBI filter press, an API-type tester made by Oil Base, Inc., measures accurately the filter losses of drilling fluids having very low loss. The bottom cell is so constructed that the holdup volume (0.08 ± 0.03 cc.) is negligible. To measure fluids with losses of 1 cc. or more, the filter press can be converted by inserting a monel screen into the bottom cap.

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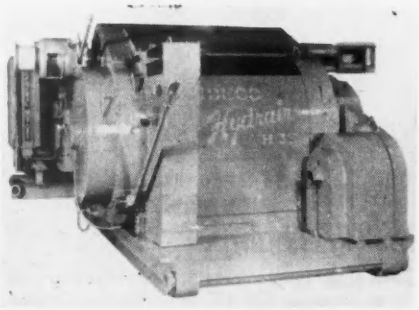

350-Horsepower Rig

This item supplements Ideco, A Division of Dresser Equipment Company, data on pages 2497-2572 of Composite Catalog, 18th Edition.

Ideco's Hydrair H-35, a 350-horsepower rig designed for one or two engine application, has enclosed oil bath lubrication of all chain drives, provision for an auxiliary hydromatic or dynamatic brake, long main and upper drums, catshaft cut-out clutch, finger tip air controls, air clutches, and torque converter performance. It is available in single and double drum models, and is rated for drilling to 5000 feet with 4½-inch drill pipe.

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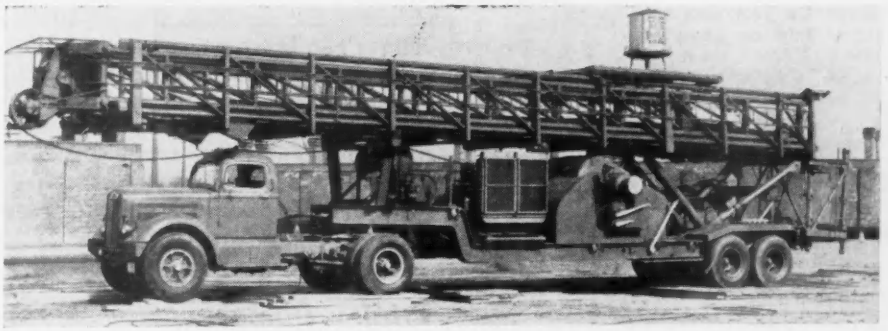

Trailer Mounted Rig

This item supplements The National Supply Company data on pages 3501-3632 of Composite Catalog, 18th Edition.

Designed for 200 input horsepower, a new Ideal Type T-20 trailer mounted drilling rig built by The National Supply Company is normally considered for drilling in the 2000-4000-foot depth range, and for servicing and workover jobs in the 4000-8000-foot range. Pictured with the mast telescoped and lowered is a rig built for D & D Drilling and Construction Company for its work of rejuvenating existing wells in eastern Venezuela. The 95-foot telescopic mast is raised to vertical by two hydraulic rams after which the inside section is elevated with cable by the drawworks, locked in position and guyed to ground anchors. Braces tie the rotary table foundation to the trailer frame, and evenly-spaced jacks under the latter provide a solid foundation to eliminate sway strains on the mast guys.

Circle No. 16 on Postcard

Air Compressor

This item supplements Cummins Engine Company, Inc., data on pages 1333-1352, and The Jaeger Machine Company data on pages 2580-2583 of Composite Catalog, 18th Edition.

Powered by a Cummins Engine Company diesel, the new Standard Model 365 air compressor manufactured by The Jaeger Machine Company is rated at 365 cubic feet of air per minute at 100 pounds per square inch pressure. It utilizes a 165 horsepower Model HRBI-600 Cummins diesel engine with an operating speed of 1240 revolutions per minute. Both compressor and engine are mounted on structurally welded main frames. The heavy duty wagon has an "autosteer" front axle, and can be hauled safely at 35 miles per hour.

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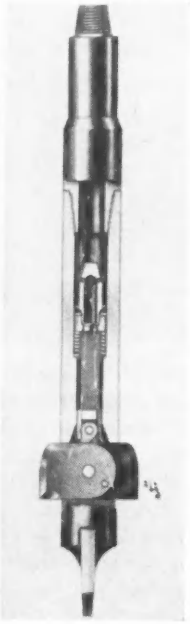
NEW EQUIPMENT

SUPPLEMENTING COMPOSITE CATALOG

To obtain additional information use convenient Reader Service Postcard on page 55. Circle number on card corresponding to number listed at the end of each new equipment item on which more information is wanted.

Wall Scraper

This item supplements Grant Oil Tool Company data on pages 1953-1976 of Composite Catalog, 18th Edition.



The new hydraulic expansion wall scraper made by Grant Oil Tool Company is a two-bladed tool that can be used to scrape the face of a producing formation and facilitate fluid flow into the hole; to open short, tight spots before running casing; to form enlarged pockets for gravel packing; and to increase the diameter of the hole at cementing points to improve the efficiency of the cement job. For directional drilling the scraper can be provided with a bull nose that extends well below the blade slot, helping to stabilize the tool. Another scraper is available for enlarging the last few feet of hole.

Circle No. 18 on Postcard

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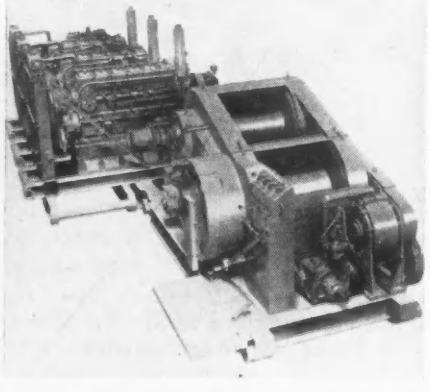
Medium Depth Rig

This item supplements Ideco, A Division of Dresser Equipment Company, data on pages 2497-2572 of Composite Catalog, 18th Edition.

Two new rigs in the 750-horsepower class have been added to Ideco's Hydrair torque converter and mechanical drive line of drilling rigs. Designed for two or three engine application, the mechanical drive model 750 rig can be converted at any time from mechanical to torque converter drive. This enables the operator to use his existing low speed engines and convert when engine replacement is necessary. The rigs are recommended for drilling to 8000 feet with 4½-inch drill pipe.



Circle No. 19 on Postcard

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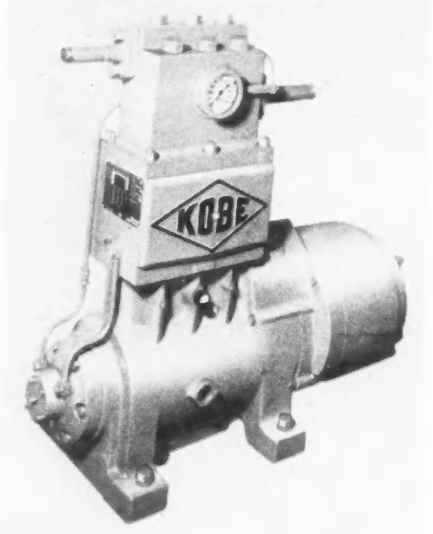
Triplex Pump

This item supplements Kobe Inc. data on pages 2725-2744 of Composite Catalog, 18th Edition.

A compact high-pressure triplex pump has been introduced by Kobe Inc. Division of Dresser Equipment Company as a heavy-duty packaged hydraulic power generator for all types of hydraulic power systems. The unit is available in 15, 30 and 50-horsepower sizes with pressure ratings up to 5000 pounds per square inch, and displacement ratings up to 60 gallons per minute. Special 10,000 psi and 20,000 psi heads are available. The pump has integral gears, available in a wide variety of ratios, and can be obtained with an integral, dripproof Sterling electric motor drive. Plungers and liners are interchangeable.



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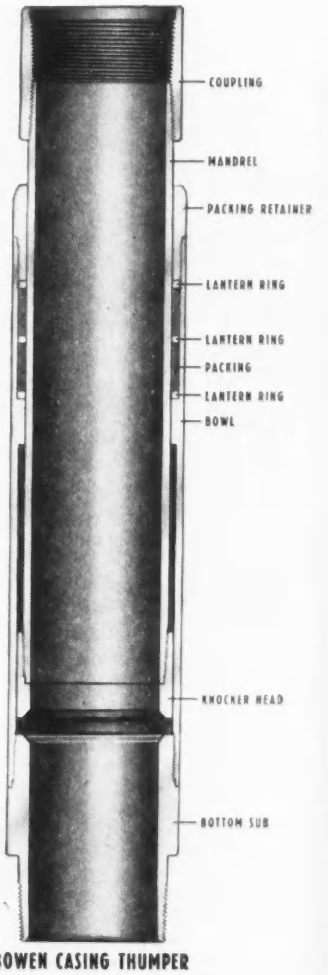

BOWEN CASING THUMPER
PATENT PENDING

Casing Thumper

This item supplements S. R. Bowen Company data on pages 781-820 of Composite Catalog, 18th Edition.

A tool for landing casing in slant holes or tight holes, the Casing Thumper made by S. R. Bowen Company provides the additional force often required to drive the casing down the hole. As shown, the mandrel and bowl are free to move longitudinally a limited amount in relation to each other and are packed off to prevent fluid leakage from either internal or external pressures. The coupling of the tool is smaller in diameter than the bowl, insuring the ability to strike blows should the bowl stick. All types of "inside the casing operation" can be conducted after the string is landed.

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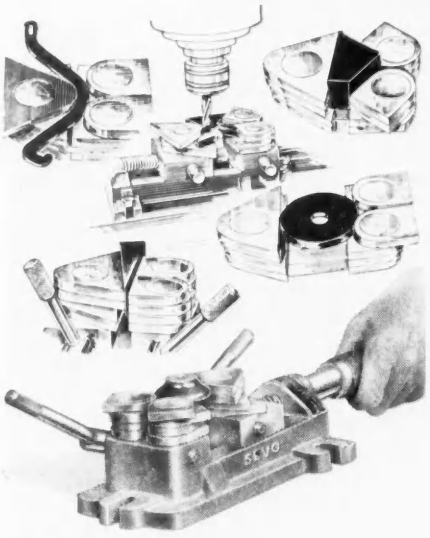
OTHER NEW AND IMPROVED EQUIPMENT

KEEP INFORMED by requesting additional information on new equipment and services described on this and following pages. SAVE TIME by using one of the free and convenient Reader Service Postcards on page 55. Circle the number on card corresponding to the number listed at the end of each new equipment item on which more information is wanted.



Universal Vise

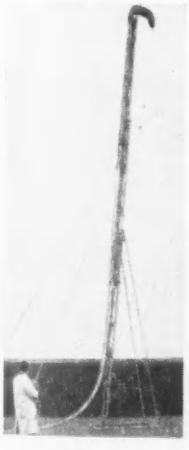
Manufactured by a Swedish concern and distributed by DeWilde-Jones, Inc., the Sevo vise is a universal screw machine that clamps round, tapered or irregular objects. Its jaws consist of a series of machined and ground flat plates which hinge or swivel in any desired direction.

Circle No. 22 on Postcard

•

Fire Fighting Tower

The new portable foam tower made by Pyrene Manufacturing Company delivers fire-extinguishing foam in large volume to the top of a tank not equipped with foam inlets or to a tank where the fixed inlets have been damaged by fire or explosion. The tower is especially adapted to use at floating roof tanks, which normally do not have foam inlets. Mobility over rough terrain, ease and speed of erection by a minimum number of men, and efficient application of foam are claimed.



Circle No. 23 on Postcard

Graphite Ground Anode

A new size 3 x 60-inch graphite ground anode, made by National Carbon Company, provides long life because there are more pounds of graphite per unit of exposed surface than in previous models. It is rugged enough to stand up to normal installation bumps without damage. The anodes are furnished with 36-inch long insulated No. 8 weatherproof cable.

Circle No. 24 on Postcard

•

Paint Roller

The American Products Company has available a new heavy duty paint roller for covering walls, ceilings, floors and structural steel. The lambswool roller works with all kinds of paints, and is interchangeable by means of a "Flip Lock." A four-foot handle is standard, but longer poles may be used.

Circle No. 25 on Postcard

•

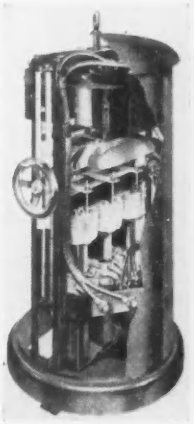
Oscillograph

Consolidated Engineering Corporation's new 5-114 Recording Oscillograph is a multi-channel instrument for analysis and measurement of strain, vibration, pressure, acceleration and other phenomena. It records photographically up to 18 static or high-frequency phenomena simultaneously.

Circle No. 26 on Postcard

Welding Machine

A new heavy duty direct current welding machine made by A. O. Smith Corporation is free of stack failure. This is accomplished by directing a high velocity downdraft of cool air over the rectifier stacks before passing the air through other parts of the machine. The blast is expelled at the base of the welder. The machine is available in 200, 300 and 400 ampere ratings.



Circle No. 27 on Postcard

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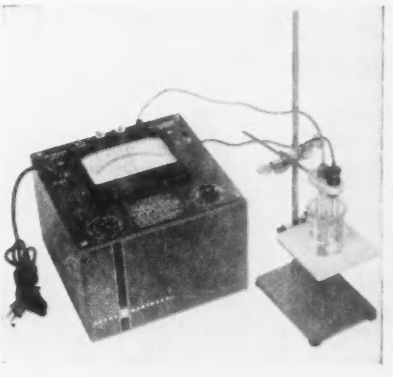
pH Indicator

A new line-operated pH indicator and vacuum tube voltmeter, developed by Leeds & Northrup, is unaffected by normal fluctuations in line voltage or by zero drift of the amplifier. A converter-type instrument, its circuit uses d.c. to a.c. conversion, a.c. amplification, and conversion back to d.c. for voltage feedback. Conversion stabilizes zero; feedback stabilizes gain. Used as pH indicator, the instrument reads directly in pH. As vacuum tube voltmeter, it can be used with any high or low impedance electrode system which develops potentials within range of the instrument.



Circle No. 28 on Postcard

To obtain additional information use convenient Reader Service Postcard on page 55. Circle number on card corresponding to number listed at the end of each new equipment item on which more information is wanted.

Magnetic Fishing Tool

A magnetic fishing tool of the permanent magnet type has been developed by K & G Tool & Service Company, for use in "insurance runs" and other fishing operations such as removal of bits, cones, bearings, etc. The tool is attached to the drill pipe or tubing by means of a threaded connection. It utilizes a reverse circulation system and a rotary shoe to loosen metallic junk in the hole and bring it within the magnetic field. This field is controlled and localized directly at the pole plate.

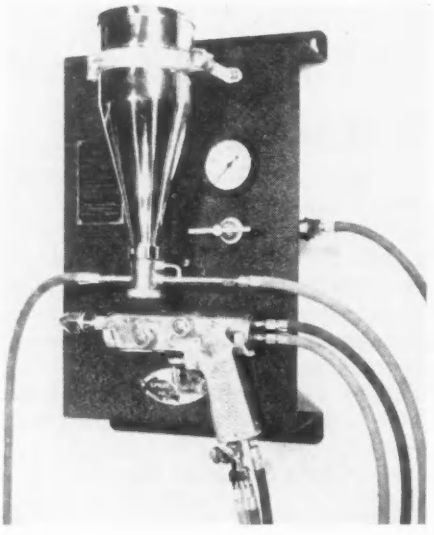
Circle No. 29 on Postcard

•

Metallizing Guns

Two new metallizing guns made by Metallizing Engineering Company, Inc., incorporate a jet siphon principle in the gas head which automatically compensates for variations in gas pressure as high as ten pounds, and provides a steady, unvarying flame for uniform coatings. The Metco Type 4E is used for machine element work, and Type 5E for corrosion protection coatings.

Circle No. 30 on Postcard



Welder

Wall Colmonoy Corporation's new model Spraywelder is a powder metallizing unit used to execute the Colmonoy Sprayweld process, which consists of applying uniform overlays of Colmonoy hard facing alloys, and then subsequently bonding the overlay to the base metal. It can be used to apply metal powder castings such as copper, brass, stainless, aluminum and zinc. The new model has trigger mechanism with finger tip control for continuous or intermittant spraying. A locked feed device on the carburetor eliminates possible change in powder feed setting.

Circle No. 31 on Postcard

•

Cleaning Unit

Kelite Products, Inc., is now making a Power Master cleaning unit for heavy duty. It has two high pressure steam guns, each delivering 150 gallons per hour. There is also a high-pressure water gun supplying hot or cold water at a pressure of 500 pounds per square inch. The power blast delivers 1000 gallons of water per hour for blasting away accumulations of mud, muck, heavy grease, etc. The water gun can also be used for de-icing operations.

Circle No. 34 on Postcard

Paraffin Scraper

Tripplehorn Company's new Triple-Spiral paraffin scraper covers a tubing well area which meets or overlaps the area covered by another scraper. The scraper is made of spring steel, blade die formed, and heat treated to form a triple spiral the inside diameter of the hole, one-eighth inch less than the outside of the rod, insuring a spring tension grip on the rod. The scraper resists 2350 pounds pressure before slipping, tests show.

Circle No. 32 on Postcard

•

Combustible Gas Alarm

Because of its explosion-proof construction, the new Johnson-Williams, Ltd. Model EE combustible gas alarm can be installed directly in the suspected atmosphere, either indoors or out. The sensing unit is weatherproof, as are all parts of the unit. By convection and diffusion, the surrounding atmosphere is subjected to a continuous watch against the build-up of any kind of explosive vapor. Presence of such vapor is signaled by a bright red indicator light as well as by remote alarm units.

Circle No. 33 on Postcard

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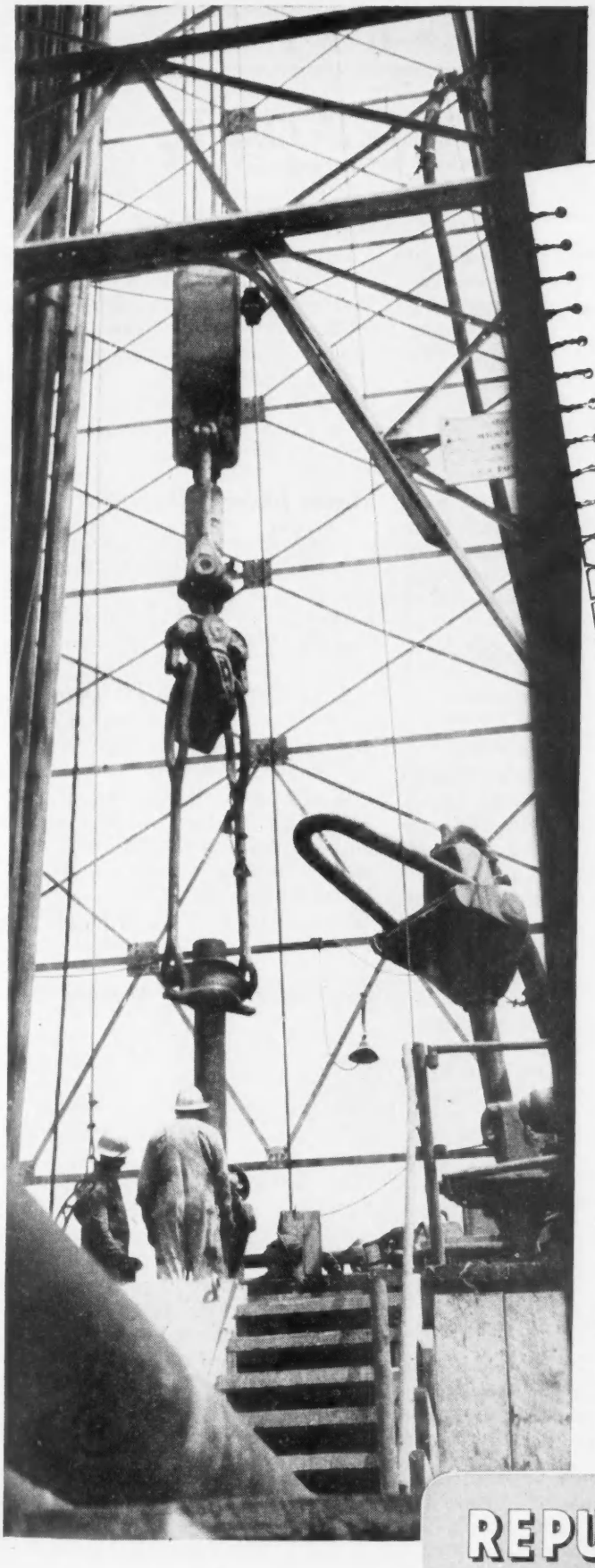

REMINDERS OF GOOD CASING PRACTICES:

How to save strings from shock loads

Casing strings should be picked up and lowered carefully, and care exercised in setting slips to avoid shock loads. Dropping a string even a short distance may loosen couplings at the bottom of the string. Care should be exercised in setting casing down on bottom, or otherwise placing it in compression because of the danger of buckling, particularly in that part of the well where hole enlargement has occurred.

Reprinted by permission from "API Recommended Practice RP5C1: Care and Use of Casing, Drill Pipe and Tubing."

. . . and, remember that

REPUBLIC
Electric Weld Casing and Tubing

- *Make-up fast*
- *Resist collapse*
- *Resist pull-out*

. . . because they're uniformly round, uniformly strong, uniformly straight, and uniform in wall thickness. Each length is formed from high ductility steel, fully normalized for uniform structure. Casing is cold sized to further increase its high yield strength. Clean, full-formed threads stab, spin-in and tong-up fast . . . and tight. The uniform depth of tough steel under thread roots all around the pipe protects against pull-outs. You can specify "Republic Electric Weld" with confidence.

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NEW LITERATURE

Copies may be obtained easily and without cost by using Reader Service Postcard. Just circle on the card the number at the end of each item in which you are interested. The convenient Postcards are on page 55.

Separation Process

The BS&B Glycol Injection System, a low temperature separation process with an inhibitor added to prevent hydrate formation, is described in a new Black, Sivalls & Bryson, Inc., bulletin.

Circle No. 35 on Postcard

•

Fastenings

A new price list and stock book, covering its complete line of non-ferrous and stainless steel fastenings, has been published by The H. M. Harper Company.

Circle No. 36 on Postcard

•

V-Belts

A bulletin describing the "precision balanced" and "more grip, less slip" features claimed for Condor V-belts has been issued by Raybestos-Manhattan, Inc.

Circle No. 37 on Postcard

•

Bulldozer

A two-color broadside on the new 10S bulldozer built by Caterpillar Tractor Company gives complete specifications and describes operation of the machine.

Circle No. 38 on Postcard

•

Welding Accessories

Tweco Products Company's new 12-page "Twecolog" describes the line of electrode holders, ground clamps, cable connectors, terminal connectors, cable splicers, mechanical and solder type cable lugs, carbon electrode holders and "Lug-Set" block and punch for attaching solder type lugs to cables without solder.

Circle No. 39 on Postcard

•

Industrial Trucks

Application, types and operation features of the Yale "Worksaver" line of motorized hand trucks and electric stackers are discussed in a 16-page bulletin available from Yale & Towne Manufacturing Company.

Circle No. 40 on Postcard

Emulsifier

Macco Corporation has issued an eight-page bulletin on Macco Iso-Mull, an emulsifying agent producing stable homogeneous oil-in-water emulsions.

Circle No. 41 on Postcard

•

Radio Telephone

Two specifications sheets have been issued by Link Radio Corporation on its types 3035 and 3036 pack sets. The two-way radio telephone assemblies are designed for portable, fixed and aviation uses.

Circle No. 42 on Postcard

•

Hydraulic Controls

Sperry Products, Inc., has released a bulletin on the new line of Sperry Hydraulic remote controls. The controls are single tube, balanced, self-contained systems operating independently without outside sources of power.

Circle No. 43 on Postcard

•

General Purpose Pumps

Construction details on Allis-Chalmers grease-lubricated pedestal-mounted general purpose pumps (Type SSB) are given in a new bulletin. The pumps are rated in capacities to 2500 gallons per minute at heads to 550 feet.

Circle No. 44 on Postcard

•

Radio Equipment

A 212-page catalog, covering "Everything in Radio, Television and Industrial Electronics," has been published by Allied Radio Corporation.

Circle No. 45 on Postcard

•

Blast Cleaner

Uses of the "Vacu-Blaster," movable blast-cleaning equipment for metal, concrete, brick, stone or wood surfaces, are detailed in a new catalog released by Vacu-Blast Company, Inc.

Circle No. 46 on Postcard

Welding Problems

Eutectic Welding Alloys Corporation's "1951 Data File of Defense and Maintenance - Conservation Welding Problems" contains more than 100 pages of illustrated technical data on maintenance and repair welding problems and procedures.

Circle No. 47 on Postcard

•

Motor-Driven Pumps

Standard models and models designed for special applications are described in a new bulletin on Motor Driven Controlled Volume pumps manufactured by Milton Roy Company.

Circle No. 48 on Postcard

•

Steel Manufacture

A complete presentation of Pittsburgh-Des Moines Steel Company and its many steel plate and structural products is made in an illustrated 32-page brochure.

Circle No. 49 on Postcard

•

Explosion-Proof Motors

Totally-enclosed and explosion-proof motors are the subject of a new multi-color bulletin issued by U. S. Electrical Motors, Inc. Application data and construction details are included.

Circle No. 50 on Postcard

•

Fire Protection

American-LaFrance-Foamite Corporation has published a 32-page booklet, "Correct Fire Protection," which tells about modern fire-fighting devices and the different extinguishing agents used in them.

Circle No. 51 on Postcard

•

Electric Heaters

"Packaged" electric heaters made by Edwin L. Wiegand Company, including immersion, circulation and other heaters with built-in controls, are illustrated in a new two-color folder. The complete Chromalox line is discussed.

Circle No. 52 on Postcard

GEOLOGY OF THE ELK CITY FIELD

By ROBERT J. BEAMS

Sunbeam Oil Corporation
Oklahoma City and Ardmore, Okla.

THE Elk City field is on an anticlinal structure in Twp. 10 North, Rs. 20, 21 and 22 West, Washita and Beckham Counties, Oklahoma, on the north front of the Wichita Mountains, near the axis of the Anadarko Basin.

Subsequent to gravity and seismic exploration, the field was discovered by Shell Oil Company's J. G. Walters 1, NE SW 14-10n-21w, completed in November, 1947, from 9260-360 feet with an initial daily production of 470 barrels, 65.4 gravity API condensate, 25 barrels of fresh water, and 5650 Mcf of gas. Crude was discovered and first produced by the field's third well, the Shell-Long 1, in NE SW 15-10n-21w, completed in February, 1949, from 9040-80 feet, with initial production of 2345 barrels, 49.1 gravity crude, 70 barrels of fresh water and 3661 Mcf of gas.

Development has proven several reservoirs in the Missouri series of the Pennsylvanian to be productive of condensate, oil, and gas at 8800-10,600 feet. The field has a productive extent at present of 9½ miles in length and two miles in width as determined by 111 wells producing condensate and crude. The probable productive limits have not been indicated along the elongated axis of the field and can be expected to be materially greater than the present length; but two dry holes on the north flank and three on the south flank restrict the probable productive width to less than three miles.

Effective January 1, 1951, a unit operation was formed to facilitate recycling and pressure maintenance. Near completion is a gasoline plant which will process and reinject gas to this unit which consists of 81 wells on 3240 acres. Additional wells and productive area will be added to the unit in the future as development of the field progresses.

The productive magnitude of this field, although still undefined, is sufficient to merit a major field classification, and the oil and gas recoveries justify the future exploration for similar accumulations in the vast and relatively unexplored Anadarko Basin.

NOT SINCE the West Edmond discovery about six years ago has a strike of such significance and importance been made in Oklahoma as Shell Oil Company's Elk City pool. It is believed the accompanying article describing the geological features of this important discovery will furnish information which may be successfully applied in future exploratory ventures in the general area.

Companies presently operating production in the field are Shell Oil Company, Union Oil Company, United Carbon Company, Wilcox Oil Company, E. Constantine, The Superior Oil Company, Tide Water Associated Oil Company, Continental Oil Company, J. M. Huber Corporation, Max Pray, Northern Ordnance, and Decem Drilling Company.

About the Author

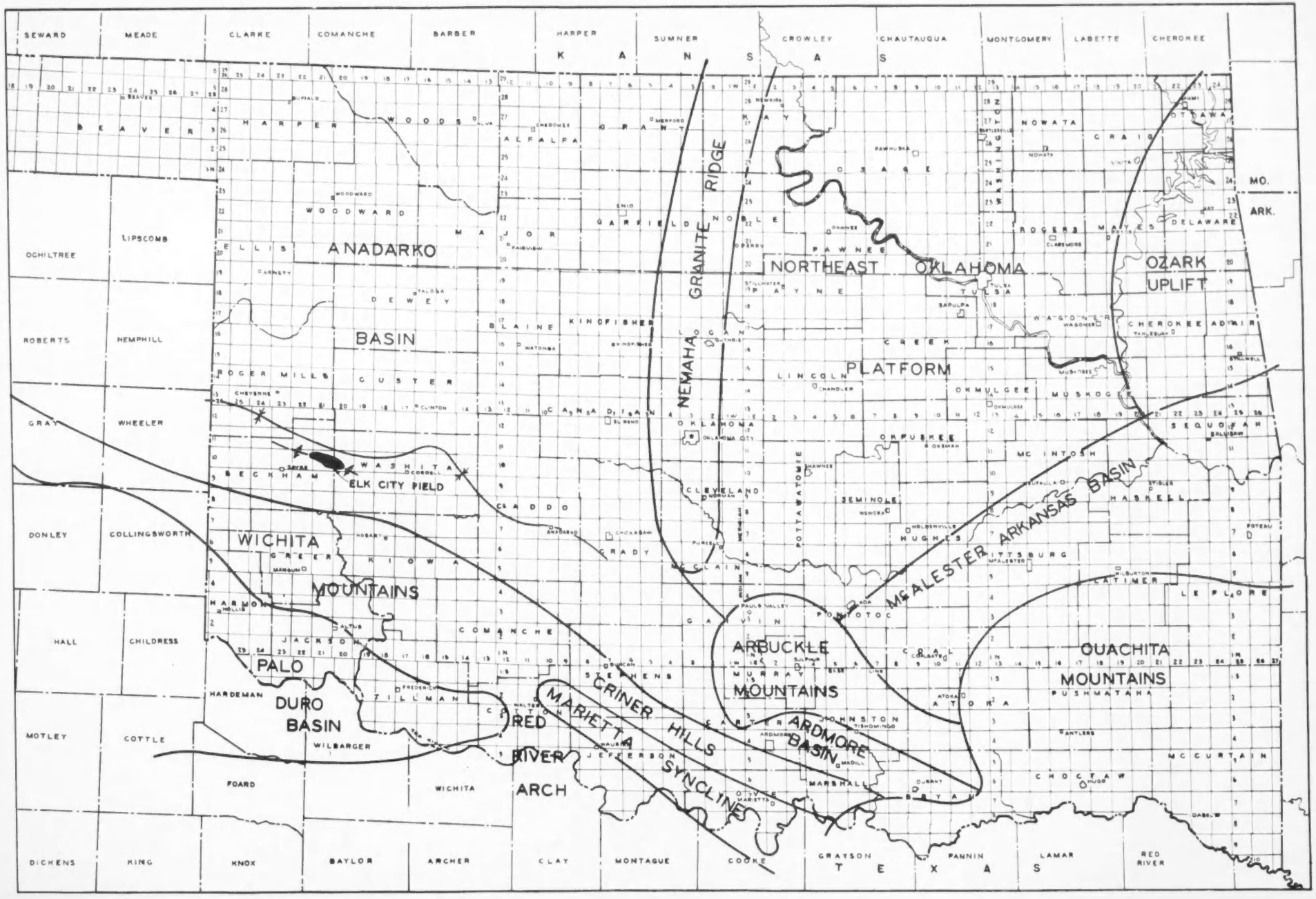
ROBERT J. BEAMS directs the activities of Sunbeam Oil Corporation at Oklahoma City and Ardmore, Okla. Previous to organizing this company, he was employed for seven years by Shell Oil Company, followed by three years of independent consulting work in the Mid-Continent area as geologist and petroleum engineer.

During the latter part of 1949, Consolidated Gas Company built a 12¾-inch line from its station at Carpenter, Okla., to Elk City field, and to date, this represents the only outlet for gas sales. Shell Pipe Line Company is exclusive purchaser for the field's oil and condensate, which is transported through a ten-inch pipe line system to Cushing, Okla., and thence to the refinery at Wood River, Ill. Additional and competitive transporting facilities will probably be installed by other companies in the future in view of the magnitude of the proven and potential oil and gas reserves.

General Geology and Structure

The Elk City Anticline is in the southern portion of the Anadarko Basin, as shown on Figure 1. It is on the basin's south flank but near the axis and is on the north front of the Wichita Mountains. The tectonic and sedimentary environment has been controlled primarily by geological conditions in the Wichita Mountains.

None of the deep seated history is known; but folding at this feature did occur at least as early as postMissouri and preVirgil time. Angularity at this unconformity exhibits about 200 feet of truncation differential between the flanks and crests of the present anticline. Folding occurred contemporaneously with deposition during Virgil and Permian time as shown by sedimentary thinning over the anticline at a rather uniform rate. Final anticlinal folding occurred in late or post-Permian time. As shown in Figure 2, the structure within the Missouri series of the Pennsylvanian system, at a depth of 9500 to 10,000 feet, is an elongated anticline trending west-northwestward about five to six miles wide and at least 12 miles long with average dips on the flanks of about 4½ degrees and a total probable closure exceeding 800 feet. Closure within the present productive area amounts to about 530 feet. Future drilling may determine this Elk City Anticline to


SEWARD
MEADE
CLARKE
COMANCHE
BARBER
HARPER
SUMNER
CROWLEY
CHAUTAUQUA
MONTGOMERY
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KANSAS
BEAVER
HARPER
WOODS
ALFALFA
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KAY
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NOBLE
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ANADARKO
MAJOR
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ADAIR
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HEMPHILL
ROGER MILLS
CUSTER
CANADIAN
OKLAHOMA
CREEK
LINCOLN
OKMULGEE
MUSKOGEE
SEQUOYAH
GRAY
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MCINTOSH
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MURRAY
JOHNSTON
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WICHITA
CLAY
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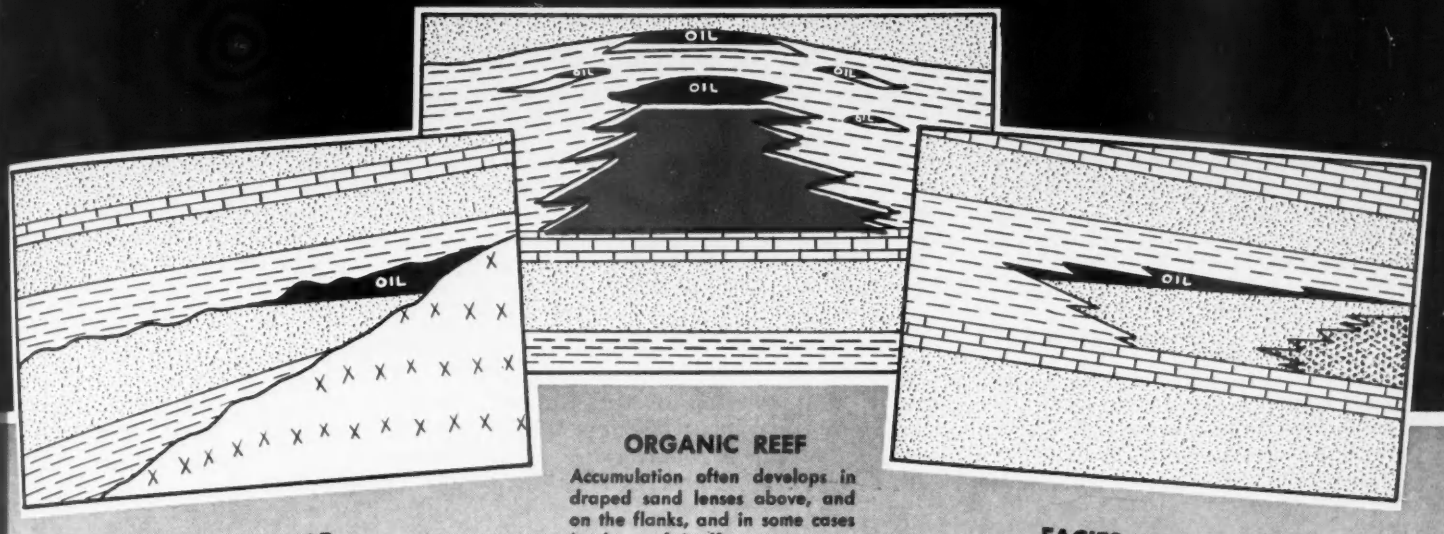
COOKE
GRAYSON
PANNIN
LAMAR
RED RIVER
DICKENS
KING
KNOX
BAYLOR
ARCHER
TEXAS
ELK CITY FIELD
WICHITA MOUNTAINS
PALO DURO BASIN
WILBARGER
RED RIVER ARCH
MARIETTA SYNCLINE
CRINER HILLS
ARDMORE BASIN
ARBUCKLE MOUNTAINS
OUACHITA MOUNTAINS
NEMAHA GRANITE RIDGE
NORTHEAST OKLAHOMA PLATFORM
OZARK UPLIFT
ARKANSAS BASIN
MCALESTER

FIGURE 1

Looking For STRAT-TRAPS?

HERE ARE 3 WELL-KNOWN STRATIGRAPHIC ACCUMULATIONS



OVERLAP

Accumulation may occur on the flanks of submerged land masses in zones of sand pinch—or wedge-out.

Example — EDISON FIELD, CALIFORNIA

ORGANIC REEF

Accumulation often develops in draped sand lenses above, and on the flanks, and in some cases in the reef itself.

Example —
MARINE POOL, ILLINOIS

FACIES CHANGE

Subsequent tilting may result in stratigraphic accumulation along the up-dip edge of the porous facies of a formation.

Example — CUT BANK FIELD, MONTANA

FIGURE 1

S S C . . . . . RECOMMENDS THE FOLLOWING GENERAL APPROACH TO THE SEARCH FOR STRATIGRAPHIC TRAPS

1. Consolidate all geologic information with particular reference to changes in lithology in the prospect area.
2. Obtain all available velocity information.
3. Make detailed velocity tests in all prospect wells, placing special emphasis on the determination of *interval velocities.*
4. Make full use of the opportunities presented by the continuous profiling method to assemble mass seismograph data, placing special emphasis on interval times—(TRACE ANALYSIS).
5. Separate time differentials caused by structural deformation or tilting, from differentials attributable to changes in lithology—(MAKE RESIDUAL MAPS).
6. Extrapolate from geologic control using imaginative geophysics.

A series of two advertisements showing 6 well-known stratigraphic accumulations.

☐ AD No. 1
1. TRUNCATION
2. BURIED RIDGES
3. SOLUTION CAVITIES

☑ AD No. 2
4. OVERLAP
5. ORGANIC REEF
6. FACIES CHANGE

Seismograph Service Corporation takes great pleasure in offering its Bibliography of Stratigraphic Traps. Its distribution is another example of S.S.C.'s unexcelled service to the oil industry.

Seismograph Service Corporation

TULSA, OKLAHOMA, U.S.A.

1952

be a culmination on an anticlinal trend of considerably greater length than presently identified.

No faulting is evident in the field by well control, although minor faults might be obscured by complex lithological facies changes.

The structure on the Wellington formation in the Permian system, at a depth of about 3400 to 3500 feet, is an elongated anticline trending west-northwestward with at least 120 feet of closure. The configuration of the Permian structure is somewhat comparable to the Pennsylvanian, and the two conform fairly well except for magnitude of closure and location of axis. The structural axis of the Permian lies about one-half mile north of the Pennsylvanian.

The geological age and lithological character of the strata in this field are described in Figure 3.

The surface beds are of Permian age and extend to a depth of about 6500 feet. The Pennsylvanian beds underlie the Permian and consist of more than 7500 feet of strata at a depth range from 6500 to below 14,000 feet. The deepest well drilled is the Continental-Proctor 1, in C NW 28-10n-20w, which penetrated the Pennsylvanian to 14,572 feet.

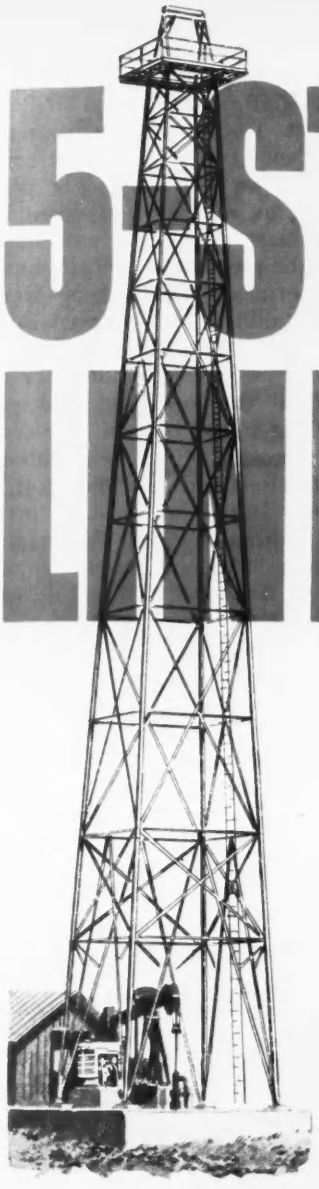
Although oil and gas shows have been encountered both above and below the Missouri series, the field is presently being exploited from the granite wash and conglomerate reservoirs from 8800 to 10,600 feet. These reservoir strata are interbedded with shale and marine limestone, but the series is predominately of a coarse clastic type which ranges lithologically from heterogeneous granite wash to pure quartz sandstone and to limestone conglomerate and may be best described generally as arkosic sand conglomerate. The Kansas City limestone, near the top of the Kansas City group, is about 500 feet below the top of the Missouri series at a depth of about 8700 feet. This limestone bed was generally used as a structural marker during initial stages of field development because it was thought to be readily identifiable from electric logs; but experience has proven that the so-called Kansas City limestone changes laterally to conglomerate and/or shale which makes its use impractical as a structural datum. A much more consistent marker is below the Kansas City limestone at a stratigraphic position within the several pay zones which reflects an average structural aspect for the Missouri series.

The coarse clastic strata at Elk City, such as those producing oil and gas from within the Missouri series, exhibit an erratic distribution of thickness and permeability. The deposition of these beds was partly of an alluvial fan type with fine to coarse rubble being dropped in the close proximity of its source, the Wichita Mountains. Laterally, these fans are the stratigraphic equivalent of fine

Geologic Section of Elk City Field

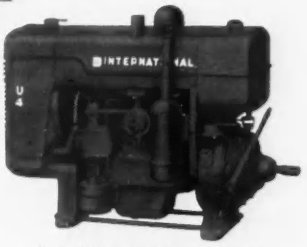
SYSTEM	SERIES	GROUP OR FORMATION		DESCRIPTION	Typical Thickness
PERMIAN	GUADALUPE	Kiger	Quartermaster	Brick red shale with bedded gypsum and some red sandstone.	405′
			Cloudchief	Red, gypsiferous sandstone, interbedded with red shale and anhydrite.	280′
			Rush Springs	Red, gypsiferous sandstone with some gypsum and anhydrite.	375′
	LEONARD	Salt Fork	Marlow Dog Creek	Red shale with some red-brown shale with interbedded red standstone and some anhydrite and gypsum.	290′
			Blaine	Light gray anhydrite, some selenite, red and gray-green shale with some light gray dolomite.	270′
			Hennessey-Garber	Red, red-brown, gray-green to green shales with some salt and anhydrite.	1925′
	WOLFCAMP	Chase Sumner	Wellington-Pearl (Panhandle Lst.)	Interbedded light gray anhydrite, red-brown mottled dense dolomite, and gray to gray-green shale with some red-brown shale.	1080′
				White to gray, pseudo-oolitic or mottled, dense limestone and gray, gray-green, and red-brown shale; some granite wash composed of light brown and light gray to pink feldspar and quartz, fairly coarse.	170′
		Council Grove		Granite wash composed of quarts and pink to orange feldspar, unconsolidated to well cemented; interbedded with red-brown and green shale, also some red, pink, and tan, conglomeratic limestone and some granular dolomite and marly crinoidal limestone.	1045′
		Admire		Granite wash composed of quartz, feldspar, red-brown and green shale with some conglomeratic limestone and dolomite.	650′
PENNSYLVANIAN	VIRGIL			Conglomeratic granite wash with calcareous arkosic matrix that contains abundant shale in upper part (very similar to Permian wash) but minor amounts of shale in matrix in lower part. Some gray to brown, normal marine type limestone which increases to abundance in lower part. Interbedded red-brown shale in upper portion and dark gray in lower portion.	1800′
	MISSOURI	Kansas City		Arkosic sand conglomerate with poorly sorted matrix of quartz and feldspar fragments. Imbedded within this matrix are pebbles of quartz, graywacke and chert which range in size up to several inches in diameter. Interbedded with gray and red shale, conglomeratic limestone, and marly to dense, buff limestone.	500′
			(Kansas City Lst.)	Predominantly arkosic sand conglomerate as above; also beds of fine sandstone, some tan to light brown, dense limestone; interbedded with thin beds of green shale and gray to black shale partly sandy and calcareous; includes four to five zones productive of gas, condensate and oil.	1130′
		Bourbon- Bronson		Arkosic sand conglomerate with beds of conglomeratic limestone and arkosic sandstone; also, a section of light gray, silty limestone, some dolomitic conglomerate; includes one to two zones productive of gas, condensate and oil.	460′
	DES MOINES			Light brown, siliceous limestone; gray, marly limestone; arkosic sand conglomerate interbedded with reddish-brown and gray shale; and fine grained, calcareous, arkosic sandstone.	430′
				Arkosic sand conglomerate and conglomeratic dolomite with few beds of reddish brown shale, light gray and tan, sandy, slightly siliceous limestone with some dark shale.	575′
				Light tan and gray, fine grained, calcareous sandstone, grading into sandy limestone; also white to light gray calcareous arkosic sandstone, and arkosic sand conglomerate, interbedded with limestone.	300′
				Light brown and light gray sandy marl; fine limy sandstone with some opaque gray chert and in small part carbonaceous and micaceous; dark gray and gray green shale, partly finely micaceous.	710′
				Tan to gray dolomite partly sandy, and black dolomitic shale with some conglomerate of limestone pebbles, sand, and chert; some coarsely micaceous silty sandstone. Dark gray, waxy, and platy shale; dark gray, calcareous, and carbonaceous shale, with some dull brownish gray shale. Small amount arkosic sand and some dolomite pebbles. High pressure gas zone in lower portion; composed of gray to black, shaly to sandy, nodular, dolomitic conglomerate, interbedded with gray to black carbonaceous and fissile shale with some vitreous opaque chert.	920′+

5 STAR LINE-UP



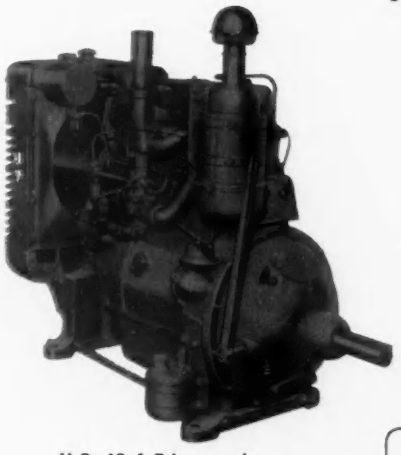
U-1, 10.5 A.P.I. max. hp. at 1800 r.p.m.

U-2A, 21.8 A.P.I. max. hp. at 1800 r.p.m.



U-4, 28.5 A.P.I. max. hp. at 1800 r.p.m.

U-6, 37.5 A.P.I. max. hp. at 1500 r.p.m.



U-9, 49 A.P.I. max. hp. at 1500 r.p.m.

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clastics and marine type limestones, such that the fluids within porous and permeable fans sometimes are contained by a surrounding barrier of impermeable material. In some instances, porous and permeable coarse clastic beds have a wide lateral distribution and continuity over several square miles; and in other cases, these porous materials were deposited as small erratics. Anticlinal structure was superimposed upon these complicated sedimentary conditions. Most of the oil and gas reservoirs in this field are anticlinal accumulations with impermeable barriers controlling only locally the distribution of commercial production on the crest of the structure, and with water defining the flank positions. In addition, some purely stratigraphic trap type reservoirs are present on the flank, and produce oil and gas at extremely low structural positions.

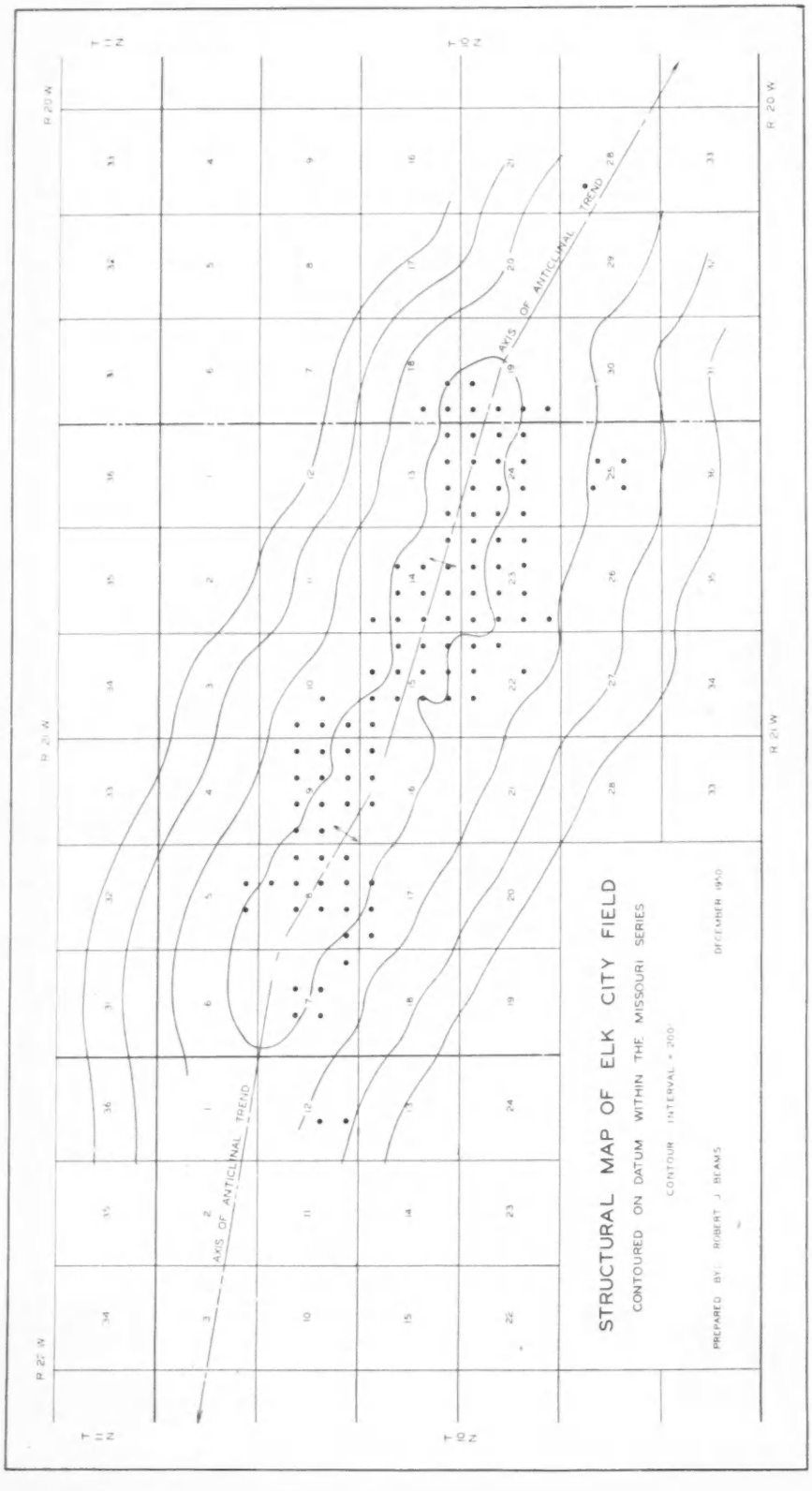

STRUCTURAL MAP OF ELK CITY FIELD
CONTOURED ON DATUM WITHIN THE MISSOURI SERIES
CONTOUR INTERVAL = 200'
DECEMBER 1950
PREPARED BY: ROBERT J. BEAMS
AXIS OF ANTICLINAL TREND
AXIS OF ANTICLINAL TREND
R. 20 W.
R. 21 W.
T. 11 N.
T. 10 N.

FIGURE 2

The arkosic sand conglomerate reservoirs exhibit a porosity gradient by zones with depth and range from 19.8 percent to 15.0 percent, from 8800 to 10,600 feet. Connate water content averages range from 33 to 40 percent of the pay zone pore space. The permeabilities, as would be expected in this type clastic rock, are extremely variable; the pay zones typically have average permeabilities ranging from 50 to 500 millidarcys. Permeabilities may be considered as effective at minimum values of one millidarcy or less, due to the low fluid and gas viscosities at initial bottom hole conditions; viscosity of oil being about .22 centipoises and gas about 0.27 centipoises. Initial bottom-hole pressures are normal for their depth, and range from 3850 pounds per square inch at 9000 feet to 4350 psi at 10,100 feet. Initial solution gas in the crude oil ranges from 1200 to 2400 cubic feet per barrel with a mean average initial gas-oil ratio of 1600/1; initial condensate/gas ratios typically range from 5000 to 10,000/1. P.V.T. analyses are often necessary to distinguish between crude oil and condensate reservoirs in this field, particularly when initial solution gas ranges from 3800 to 4900 cubic feet per barrel. Fluid hydrocarbons have an API gravity range from 42 to 63 degrees.

Development Cost

The discovery well, J. G. Walters 1, C NE SW 14-10n-21w, required 434 days to drill and complete at a total cost of $786,511, or $59.89 per foot. Included in the above cost was mud expense of $206,124. Development costs declined rapidly with field exploitation and after a dozen wells had been completed, the total cost was down to about $177,000 per well with drilling equipment in operation only 91 days. Present development requires drilling equipment in operation for a total of 60 days including cementing and completion time. Average mud cost is $8000 per well, and total completion costs including surface equipment amount to about $150,000 per well.

A typical well initially flows about 450 barrels of oil or condensate per day through a 22/64 inch tubing choke with a surface flowing pressure of 1400 pounds. As of December 31, 1950, the field had produced 5,861,500 barrels of oil and condensate from 108 wells and current production averaged 18,000 barrels per day. 22 wells have a present recovery exceeding 70,000 barrels per well and two of these wells have produced over 150,000 barrels per well.

Baash-Ross News

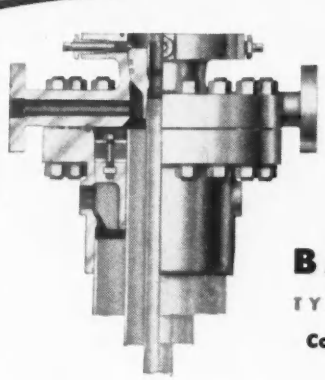
HOUSTON • OKLAHOMA CITY • NEW YORK

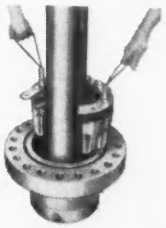
OUR 32nd YEAR

Here's what BAASH-ROSS has done to simplify your well head problems!

THREE BASIC TYPES OF UNITS MEET EVERY OPERATOR'S REQUIREMENTS

For many years Baash-Ross has been a leader in the development of more compact, more efficient Well Head Equipment. And to meet the varied requirements of present-day operations, Baash-Ross now offers three basic types of Head Assemblies—each offering certain vital advantages to save time, space, and money on your development programs . . .





BAASH-ROSS

TYPE "UPS" HEADS

Combine Pack-Off And Slips In One Unit

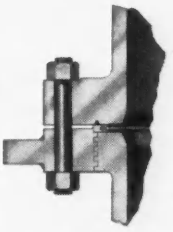
Type "UPS" Heads—a new Baash-Ross development—have the Packing Element and Slips unitized into a *single* hinged assembly that simply w-r-a-p-s around the casing and locks in place with one bolt. As the weight of the casing is placed on the slips, they *automatically* equalize themselves within the bowl to assure exact centering of the casing as well as a uniform grip around the *entire circumference* of the pipe. A few quick turns of a wrench then expands the packing element for a pressure-tight seal.

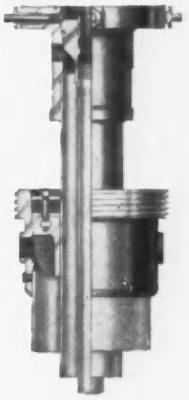
"UPS" ADVANTAGES INCLUDE . . . (1) No space wasted by threads, grooves or other packer-retaining devices—therefore overall height is reduced to a minimum . . . (2) Elimination of threads, grooves, etc., means a smooth bowl—nothing to become damaged during drilling operations, no need for protective sleeves . . . (3) Since all the slip segments are unitized together, none can set higher or lower than the rest—no risk of crimping the casing, no danger of an unequal grip that may fail in service . . . (4) Slips are set and packing is tightened around casing without stripping and without first cutting the casing. Simplifies installation—saves time!

"UPS" Heads also incorporate the unique Baash-Ross weld-testing feature which permits simultaneously testing the pressure-tightness of *both* casing welds with a gauge and hand pump as part of the installation procedure—or any time later. Any leaks discovered during the life of the well can be quickly sealed off by injecting plastic pack material.

"UPS" Equipment is available in a complete range of sizes . . . for threading or welding to the casing . . . with or without Bases . . . and for use with over a dozen different Tubing Heads Suspensions and Hook-Ups. *It is the ideal solution for a wide range of requirements on medium and low-pressure wells!*

View of Flange installed showing packing arrangement.





BAASH-ROSS

TYPE "UPS-DF" HEADS

Offer "UPS" Advantages *Plus Demountable Flanges*

Type "UPS-DF" Heads combine all the "UPS" advantages with an additional important feature—*Demountable Flanges that can be salvaged after the drilling operations for use on other installations.*

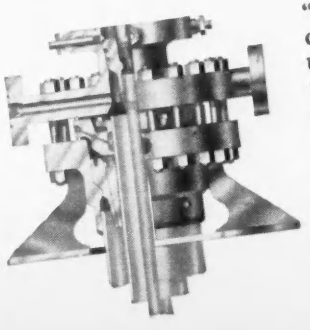
The body, packing and slips of this design are the same as standard "UPS" Heads to provide all the important "UPS" advantages outlined at left. However, the flange is attached to the main body by means of a square thread so that it can be readily removed when drilling operations are completed.

During drilling, the flange is installed on the Head to provide means for attaching standard pressure control. A unique packing arrangement—having important advantages over the conventional ring-groove design—prevents leakage between the flanges and is so placed that the square thread is not exposed to casing pressure.

After drilling is completed, the pressure control equipment is removed and the flange is unscrewed from the Head—an operation simplified by the easy make-and-break properties of the square thread. The flange, ring bolts and packing can then be used repeatedly on other wells, thus effecting important economies on multiple installations.

Available in a complete range of sizes and designs, Type "UPS-DF" equipment is the latest in a long string of Baash-Ross Landing and Casing Head advancements. *Be sure to investigate the economies this equipment can make for you!*

BAASH-ROSS TYPE "X" HEADS Provide Vital Advantages for High-Pressure Installations.



Developed several years ago to give new efficiencies on high-pressure wells, Type "X" equipment has been widely used on wells of all depths and pressures. It offers an unusual degree of simplicity, compactness and ready-adaptability to different installation requirements, and the heavy-duty pack-off provides a dependable seal against the highest well pressures. The pack-off is made in a separate unit that fits between flanges—a pressure-tight seal being formed around the casing by a double-element Packing Assembly tightened by stud bolts.

TYPE "X" ADVANTAGES INCLUDE . . . (1) No grooves or threads in the bowl of the Head—therefore nothing to become damaged or corroded during drilling operations, nothing to require maintenance or protection . . . (2) The one-piece Packing Assembly mounts between flanges for simple installation, maximum saving in space . . . (3) Unitized Slips assure uniform slip pressure, freedom from casing damage . . . (4) The Packing Assembly as well as the casing weld are so designed that the seal around the casing can be checked at any time during the life of the well, and if a leak is discovered can be readily packed-off with plastic material *without dismantling the Head or even breaking connections.*

Type "X" Heads are unusually adaptable to varying completion requirements—permit changing series-ratings and flange sizes in the Heads—and have many other unique features. They are available in a complete range of sizes, pressures and variations to meet every well requirement!

Baash-Ross Landing, Casing and Tubing Heads are available through leading supply stores.

See pages 421 through 430 of your 1951 Composite Catalog for more data on Baash-Ross Landing and Casing Heads. Or write to your nearest Baash-Ross Sales Office.

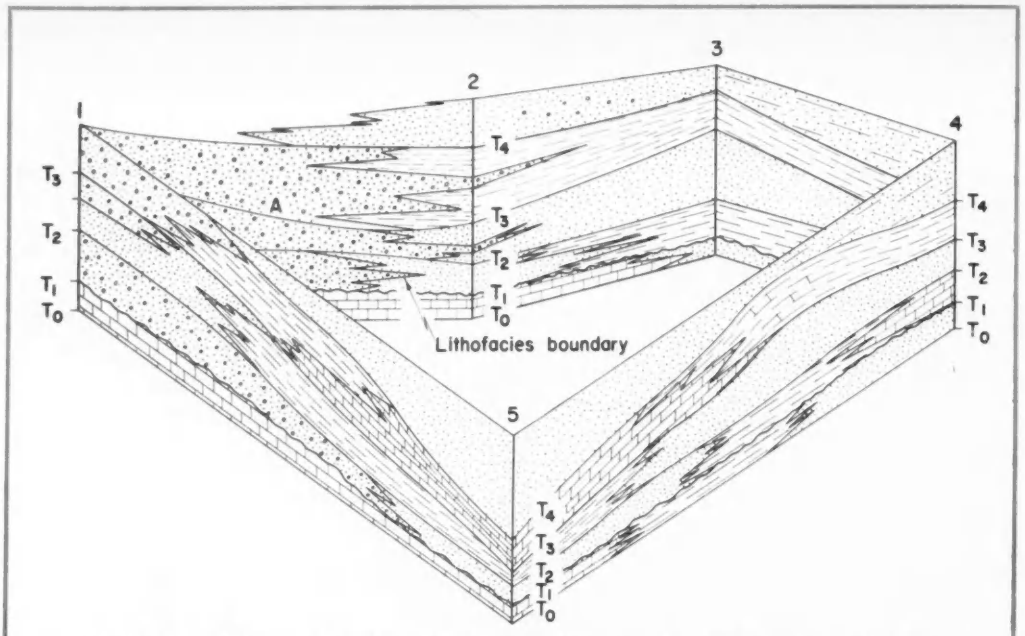


FIGURE 1. Sketch demonstrating lateral gradation and intertonguing of various types of deposits. Sediments included between the time surfaces (T_0, T_1, T_2, T_3, and T_4) represents time-rock units. Note how sediments of various composition may be included within a single time-rock unit and also how a time surface may transect a lithofacies boundary. To establish properly the stratigraphic relationships of all these deposits, it is essential that the space-time concept be applied.

The Space-Time Concept In Subsurface Geology

By DR. L. W. LEROY
Associate Professor of Geology,
Colorado School of Mines, Golden

THE following comments, relating to the space-time concept as applied in subsurface geology, are presented for those who are initiating their professional careers in this field. These remarks may also serve to rejuvenate concern and thought among those who have long practiced the profession, but who tend to neglect or minimize the importance of the variables of *space* and *time* as related to the interpretation of geological phenomena.

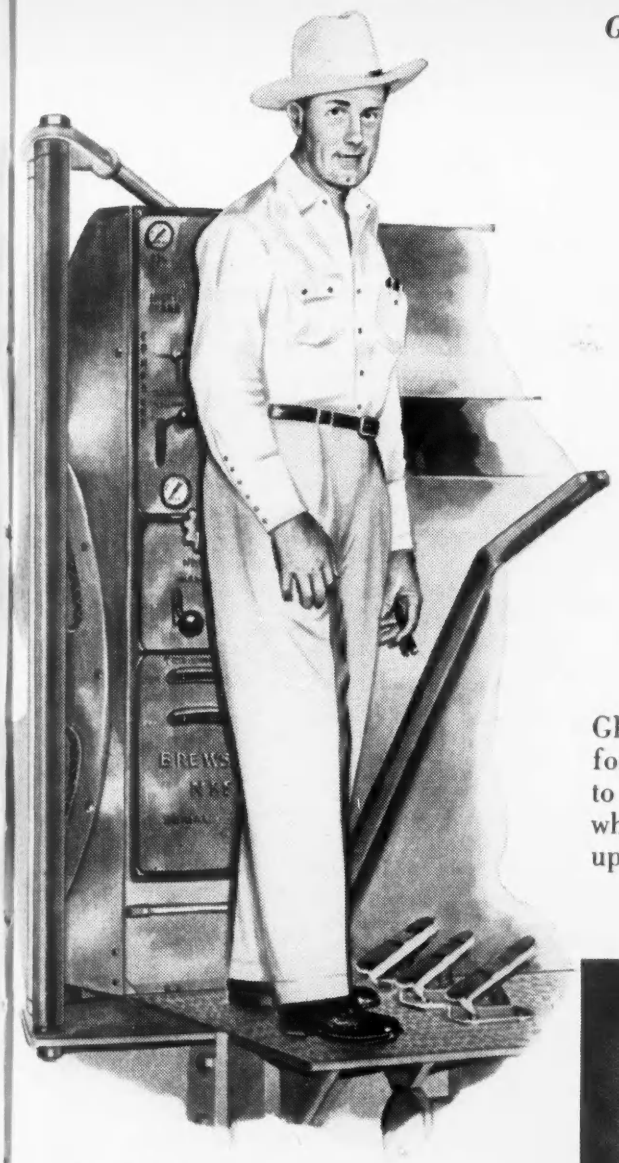
The definition of "space-time" in Webster's unabridged dictionary reads as follows: "The four-dimensional order within which every existent may be determined or located by specifying its four co-ordinates, three spatial and one temporal." The spatial components are more tangible and more evaluatable in geological investigations than in the elusive temporal variable.

The competent subsurface geologist is required to think, to plan his operations, and to interpret his results in terms of space and time; otherwise, the true character of folds, faults, stratigraphic units, and unconformities could not be properly deciphered.

IN THE SUCCESSFUL interpretation of subsurface geological conditions, there must be due consideration of the geological phenomena with respect to time as well as space. All elements of geologic structure change in space and have assumed different aspects through time. For example, an anticline may show wide diversity in closure with varying depth. The competent subsurface geologist is required to think, to plan his operations, and to interpret his results in terms of both space and time. Otherwise, the true character of folds, faults, stratigraphic units, and unconformities could not be properly deciphered.

Space-Time Concept in Structure

All elements of geologic structure change in space and have assumed different aspects through time. An anticline may exhibit extreme diversity in closure with depth; its axial and crestal surfaces may possess divergent relationships in different parts of the flexure; the degree and direction of plunge may change with depth as well as along axial projection; and flank dips will, in many instances, exhibit considerable variation within the structure. Knowledge of these changes and their relationships is mandatory before the subsurface geologist can adequately outline a drilling program, recommend a leasing procedure, or effect an accurate reserve calculation. The me-



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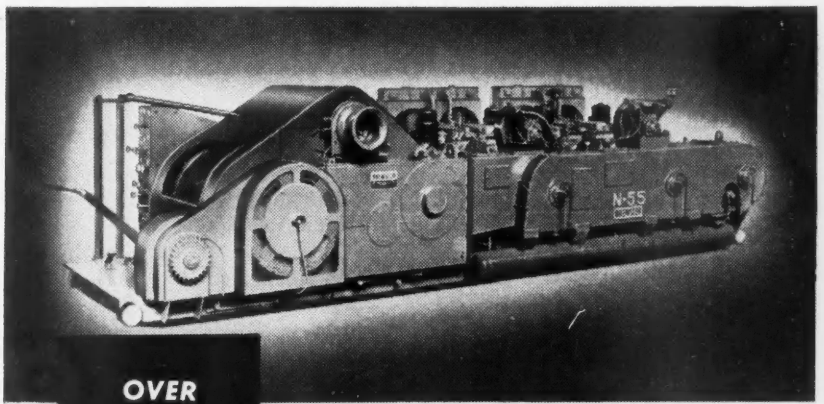
THE N-55, Brewster's little big rig — drills to 6,500′ — has 450 horsepower — is made with 2-engine or 3-engine compound — has over-all width of 8′ for easy transportation.

Glenn Peel says:

"I know what I'm getting with a Brewster Drawworks"

Glenn Peel, drilling contractor, has recently bought a new N-55 for 6,500′ drilling, and an N-4 for 4,500′ drilling, in addition to the other Brewster drawworks he owns. He says he knows what a Brewster drawworks will do to keep drilling schedules up and drilling costs down.



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chanics of deformation operating through time should likewise be gravely considered, as it may well have an important influence on the migration, accumulation, and distribution of liquid and gaseous hydrocarbons within the structure.

Joint and fault patterns exhibit extreme variation in space and have assumed different relationships during the time of their development. A fault may change in dip with depth, as well as along its strike. Stratal displacement adjacent to the fault surface may likewise vary drastically. The time and sequence of development of joints and faults are important from the standpoint of the distribution and character of oil and gas. This condition is exemplified in many fields of Eastern Venezuela.

All geologic structure must be viewed and evaluated in four dimensions

Space-Time Concept in Stratigraphy

Sedimentationists have adequately illustrated the lateral variations of modern marine deposits forming on the present time surface. They have recognized coarse clastics grading into finer clastic equivalents, which in turn merge into calcareous types. These conditions have prevailed through geologic time.

The gross aspect of sedimentary units changes laterally through space as well as shifting stratigraphically through time. Without recognizing this principle, the subsurface geologist would be unable to correlate strata properly, nor could he develop an accurate stratigraphic history of a petroliferous area.

Pike[1] in his studies of the Upper Cretaceous deposits of New Mexico, Arizona, and southwestern Colorado, has clearly demonstrated the application of the space-time concept in stratigraphic analysis procedure. The sedimentary facies relationships of the Colorado Plateau region unraveled by McKee[2] and the facies problems of the Upper Cretaceous of central and eastern Utah deciphered by Spieker[3] could not have been solved without considering the interrelationship of the variables of space and time. King, Kay, Eardley, Cooper, and Selk are among the many stratigraphers who have fully utilized the space-time concept during the solution of their stratigraphic problems.

Krumbein and Sloss[4] must be given due applause for stimulating and creating new interest in the space-time concept among present-day petroleum geologists.

Since the discovery of the Leduc and contiguous fields of Alberta, Canada, and the Scurry County fields of West Texas, considerable study has been devoted to the evaluation of space geometry of both ancient and modern reef complexes. The morphologic elements comprising these complexes are intimately involved. Composition, texture, porosity and permeability, thickness, and diagenetic variations within reefs change transitionally or abruptly both vertically and horizontally. Sediments adjacent to the reef core exhibit extreme modification in stratigraphic relationship. Such reef problems as: (a) distribution of oil, gas, and water; (b) permeability and porosity patterns; (c) drilling and completion practices; (d) estimation of reserve, and (e) development and planning, challenge the multiple-dimensional, speculative and imaginative capabilities of the subsurface geologist.

The definition of unconformities is of prime importance in stratigraphic geology. The elements and relationship of these surfaces to overlying and underlying strata rarely remain constant over extended distances. The surface may be folded, may exhibit extreme variation in relief, and may vary in age from place to place. The four-dimensional variables must be properly evaluated before these surfaces can be systematically explored for petroleum possibilities.

In recent years geophysicists have become aware that lateral lithologic changes in the stratigraphic column greatly affect seismic velocities. Therefore, a knowledge of these spatial lithologic variations is of prime importance before structural reflections can be adequately interpreted.

Space-Time Concept in Paleontology

The paleontologist plays an important role in correlating subsurface deposits. He must be constantly aware of the space-time concept. Faunal assemblages are known to adjust to their respective environments. Many different assemblages may occur along the same time surface within a given stratigraphic unit. It is also possible for specific assemblages to migrate across a stratigraphic unit as a result of shifting environments through time. Krumbein and Sloss[4] state, "The pattern of the distribution of animals and plants in three dimensions of space is an important factor in the analysis of the fossil record, and geologists are further concerned with distribution in a fourth dimension, time." One of the most classical examples of a biostratigraphic sequence migrating through space and time was demonstrated by Natland[5] in his studies of the Late Tertiary and Recent Foraminifera of the Pacific Coast region of southern California.

Definition of Time Surfaces

An absolute time surface is the most difficult and most non-tangible variable to define in geologic studies as it "has no existence, no individuality, no reality apart from the events by which it is defined" (Lowman[6]). Paleontologic evidence is the most useful means at present for delineating time surfaces, but even this evidence is far from adequate. In certain areas a lignite, bentonite, or limestone layer or an erosional surface may prove more useful as a time marker than the associated fossils.

As time surfaces transect lithofacies boundaries (Figure 1) special attention must be given the spatial components controling the distribu-

■ CONTINUED ON PAGE 80

About the Author

DR. L. W. LeROY is associate professor of geology at the Colorado School of Mines. He completed his undergraduate work in geological engineering at the School of Mines in 1933 and his doctorate in geological engineering at the same school in 1945. Between 1933 and 1942 he was stratigraphic geologist for the Standard Oil Company of California in the Netherlands East Indies, North Africa and Venezuela. He is a member of the American Association of Petroleum Geologists, Paleontological Society, Society of Economic Paleontologists and Mineralogists, and a fellow of the Geological Society of America. Dr. LeRoy has published numerous papers on micropaleontology and stratigraphy. He is the editor of the text, "Subsurface Geologic Methods."

January 18, 1907 OIL INVESTOR'S JOURNAL

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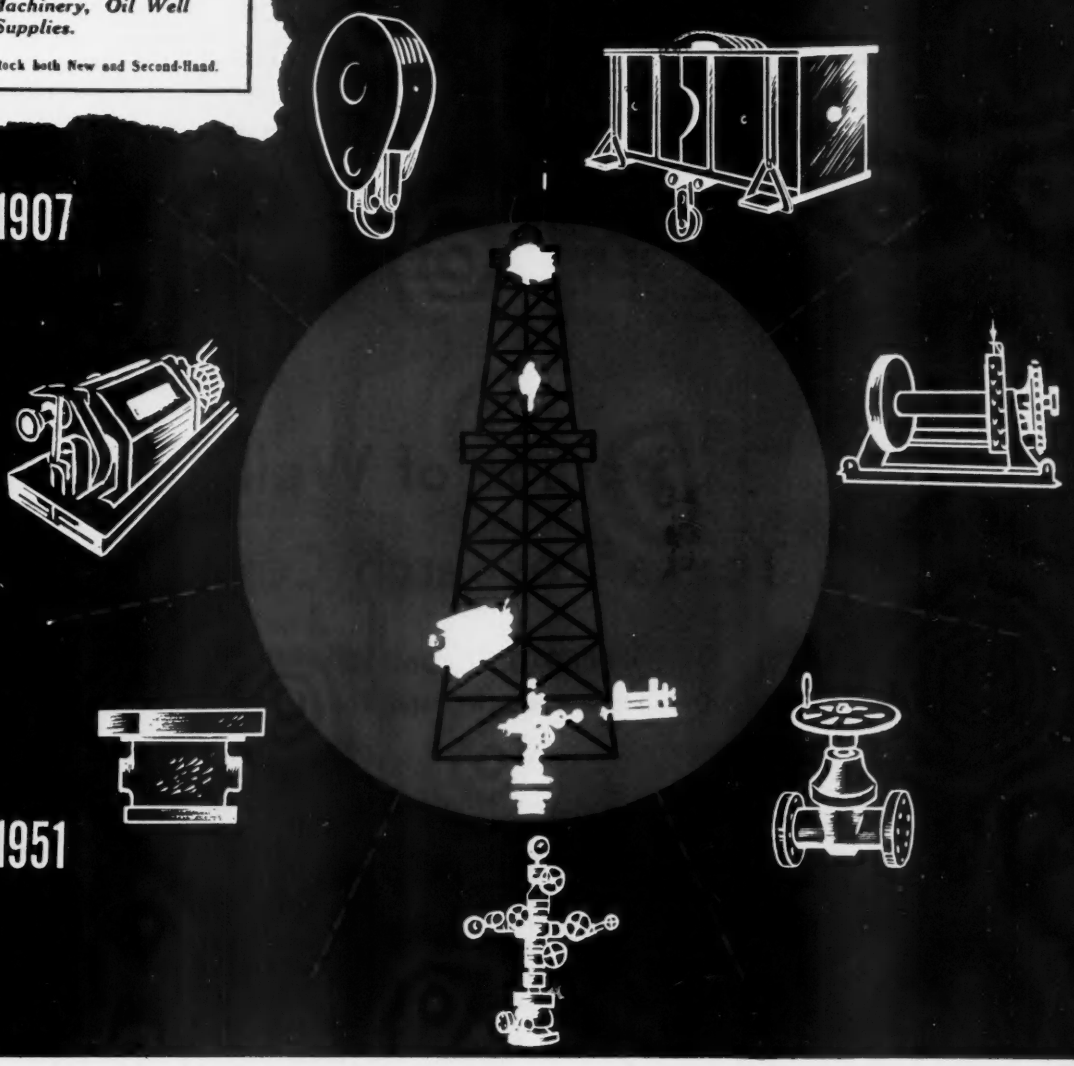

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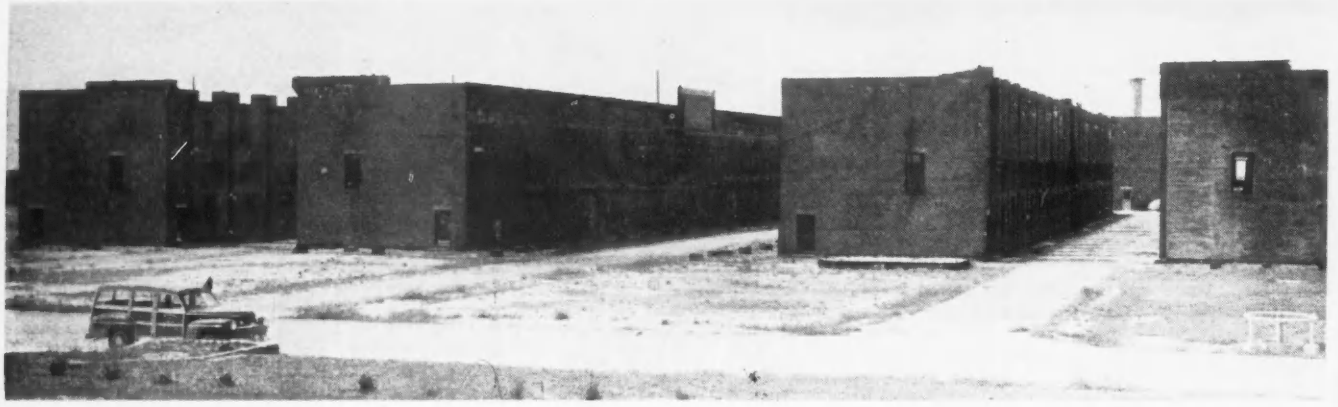


One or more of these Magnesium Cell Buildings at the University of Texas' Off-Campus Research Center near Austin could be rehabilitated to provide thousands of square feet of storage space for oil well cores and samples. The buildings have stout brick walls and concrete foundations, and during World War II formed a part of the government-owned magnesium plant which the University later acquired and is rapidly reconverting into a research facility. Twenty-six of the former plant's 32 buildings have been reconverted and now house 19 research laboratories, 15 of which are performing national defense research. The cell buildings' equipment was dismantled and sold by the War Assets Administration after the war, and the buildings themselves were left on-site for any educational or research project the University might wish to undertake.

Storage of Well Cores At Texas Research Center Proposed

By FRED D. THOMPSON, Executive Assistant
Off-Campus Research Center, The University of Texas, Austin

THERE IS a definite need in the petroleum industry for saving oil well cores for future reference and study. The industry has a good opportunity to secure facilities for storing cores by aiding the University of Texas in rehabilitating several available buildings at the Off-Campus Research Center at Austin.

RENOVATION and utilization of one or more of four large buildings at The University of Texas' Off-Campus Research Center for oil well core storage is advocated by Dollie Radler Hall as part of an educational program designed to spark the industry's interest in the necessity for preserving valuable well sample and core material.

Mrs. Hall, prominent Tulsa geologist and chairman of the Committee on the Preservation of Samples and Cores of the American Association of Petroleum Geologists, inspected the buildings recently while in Austin attending the combined 1951 regional meeting of the association and the 18th annual meeting of the South Texas Geological Society.

The buildings, which actually are merely shells of buildings, but which have stout brick walls and excellent concrete foundations, are located next to the University's Well Sample and Core Library, which functions under the direction of Dr. John T. Lonsdale, head of the institution's Bureau of Economic Geology.

Dr. Lonsdale, a member of the Hall Committee, and other interested geologists and oil company executives, long have been anxious to rehabilitate one or more of the buildings to form a permanent home for many valuable cores now being discarded.

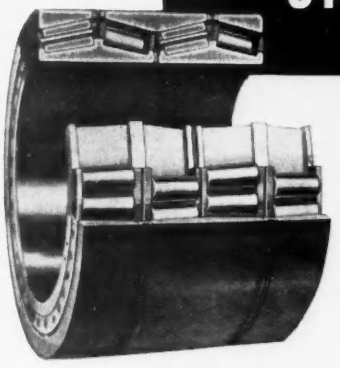
Dr. Lonsdale, pleaded at the Austin meeting for oil companies to cooperate in the preservation of samples and cores, but it remained for Mrs. Hall to focus attention on the possibility of an educational program being centered around sample and core preservation in general, and the benefits to be gained by the industry in taking advantage of the situation that exists at the University's Off-Campus Research Center.

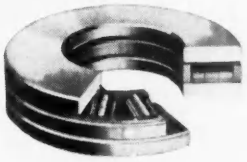
For several years conversion of one or more of the buildings for core storage purposes has been under consideration by J. Neils Thompson, director of the Research Center. The holdup always has been—no funds.

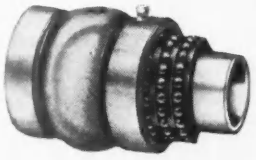
Apparently Mrs. Hall's committee has hit the same stumbling block. In the committee's report to the association it declared that it "found that to achieve the objective of the problem of core preservation is not feasible within the association itself because of the need of financial assistance; but the principle of preservation of cores is of so much importance to the profession and to the industry that we recommend that the executive committee of the Association present the problem for consideration to the API."

But Mrs. Hall is not content with having made a somewhat forlorn report. Financial assistance will be forthcoming, she said, if geologists and oil company executives are impressed with the immense waste of sample and core material that plays so vital a part in the profitable operation of the entire oil industry.

"The buildings at the Off-Campus Research Center, which can be put in shape for a comparatively small







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amount of money, offer the industry an opportunity to create one of the largest and finest core depositories in the entire Southwest," she declared.

"It is only by hammering home the importance, in dollars and cents returns, of samples and cores that the industry ever will be convinced of the need for ample storage room for preservation of this material," she continued. "A tremendous educational program is ahead of us, and we might as well start right here by letting the industry know that ample storage room for this area at least can be provided at minimum cost at the University's Off-Campus Research Center."

The Research Center property during World War II was occupied by a government-owned magnesium plant which produced the metal for use in fire bombs. The four buildings in question were then known as the Magnesium Cell Buildings. After the war the equipment in the buildings was dismantled and sold by the War Assets Administration. The University leased the property in 1946, and in December, 1949, acquired title to it under a contract calling for payments to be made over a 20-year period—not in cash, but in educational and research benefits accruing to the public from its use.

Most of the buildings have been reconverted into research laboratories, now numbering 19. However, no attempt has been made to rehabilitate the Magnesium Cell Buildings. They are four of the largest buildings at the Research Center, each having 55,600 square feet of floor space. It has been estimated that if two of the buildings were placed under one roof and three floors provided for each building, a minimum of well over 350,000 square feet of floor space would be available for oil well core storage. The cost of such a rehabilitation program has never been officially estimated.

The association's committee investigating the possibility of better facilities for sample and core storage "could not escape the conclusion," Dr. Lonsdale said in his address, "that the science of geology has lost in the past and is continuing to lose samples and cores of fundamental scientific importance. In addition, many of the samples and cores which were discarded would have been of value in petroleum exploration subsequent, in some instances many years subsequent, to the date the wells were drilled."

Mrs. Dollie Radler Hall, Tulsa geologist and chairman of the Committee on the Preservation of Samples and Cores of the American Association of Petroleum Geologists, believes the industry should do something now to conserve an irreplaceable source of scientific information. She explains her views in the accompanying article.

The growing importance of special techniques such as the electric log has created, he said, a tendency to reduce the importance of well samples and cores.

"I am informed, however," he continued, "that the new techniques furnish no universal solution for subsurface problems. They are valuable tools supplementing information derived from samples and are based on physical properties of rocks. The electric log does not chart variable features of a column of air, but a column of rocks. The drill penetrates not alpha rays or neutrons, but rocks. The structure is recorded in rocks. The oil and other fluids are not in great underground caverns or rivers, but in rocks. The fossils, the variations in thickness, lithology, porosity, permeability and other features so important scientifically and commercially are recorded not in some mysterious medium subject to instrumentation, but in rocks. Only the samples and cores even with revolutionary techniques of today still give us a chance to see the rocks. Even if a direct method of locating oil should be developed, the need for the actual subsurface materials still would exist."

The Space-Time Concept

■ CONTINUED FROM PAGE 76

tion and relationship of facies, lithotopes, tectotopes, and biotopes. In many instances time surfaces are impossible to establish.

Obtaining Space-Time Values

The solution of subsurface geologic problems involving the space-time concept depends on the quality and quantity of available data and on the ability of the co-ordinator. The sources of these data include: well logs (lithologic, electrical, radioactive, caliper, drill-time, micro), controlled stratigraphic and biostratigraphic sections, geophysical information (seismograph, gravimeter, magnetometer), regional and local geologic mapping, tectonic studies, and laboratory procedures (insoluble residue, thin and polished sections, X-ray analysis, heavy-mineral and spectrochemical analysis, paleontological investigations).

It is the responsibility of the subsurface geologist to be familiar with these methods—to know their limitations and to integrate the data properly before attempting to solve problems controlled by the variables of space and time.

In conclusion, the importance of space geometry for deciphering any geological situation is again stressed. Problems demanding application of this concept should first be *generalized* and then *detailed*. This stage is followed by periodic *regeneralization* and *redetailing*. It should be recognized that every plan, operation, and conclusion made by those in the geological fraternity is bounded and governed by the four-dimensional surfaces. Those responsible for the training of young geologists should make every effort to emphasize the significance of the co-ordinates of space and the element of time in surface and subsurface interpretations.

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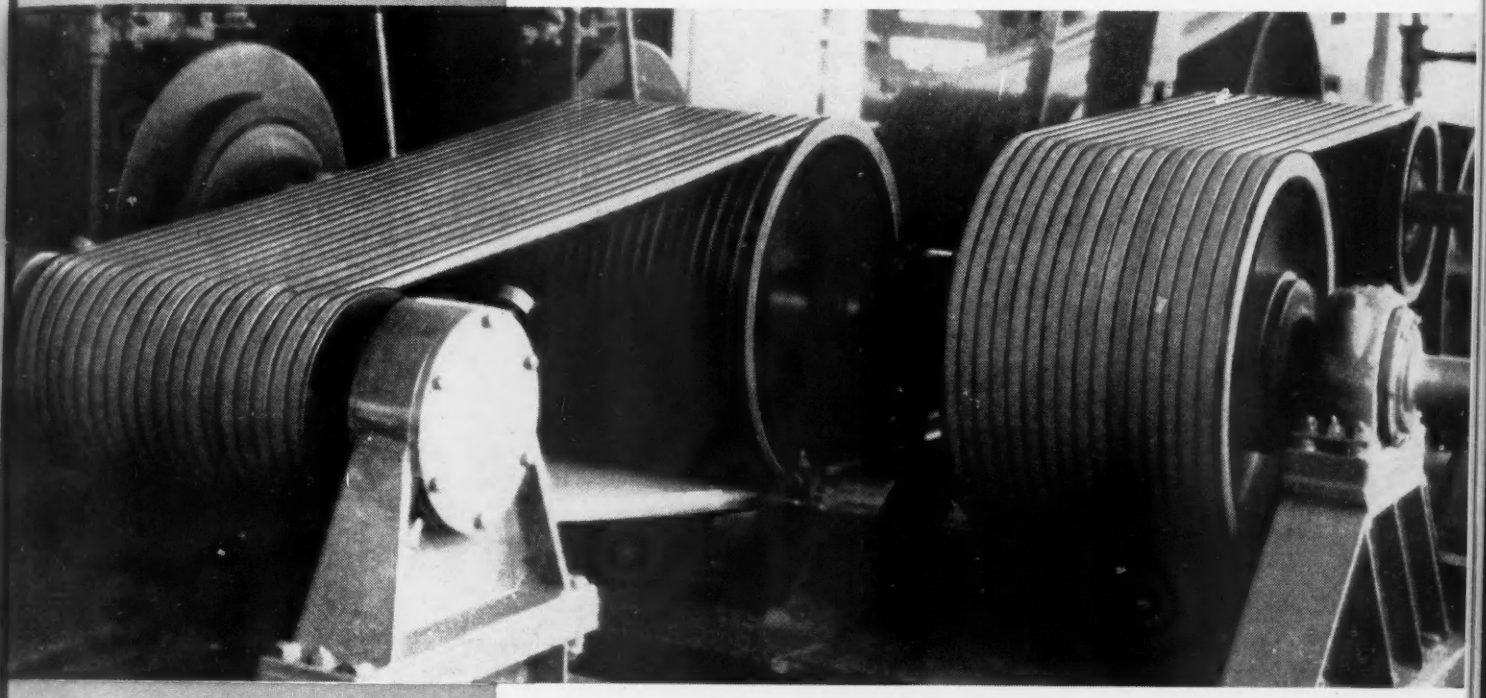

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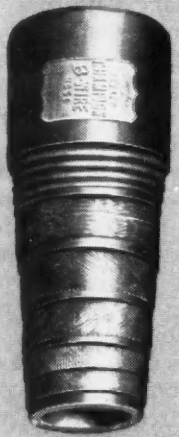

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The type of plane used in the flying laboratory service is ideally suited to the small fields and rough terrain that may be found at remote wildcat well locations. With the flying service, the base laboratory is brought to within only several hours of even remote wildcat wells in the Rocky Mountain region.

Air Service Speeds Well Cores

By JAMES E. CAMPBELL

Chemical and Geophysical Laboratories, Casper, Wyo.

EXPLORATION work in the Rocky Mountain area is receiving valuable aid from a flying laboratory service that brings the base laboratory to within a few hours of remote wildcat well operations.

The light plane generally assigned to this work is not as fast as some types but has certain advantages. It can be landed on a nearby road or field and bring important cores back to the laboratory, enabling test results to be telephoned back to the well within a few hours. Actual cost of the flying service is relatively small when compared with other costs, such as rig shutdown time, that would be involved if automobile or other forms of transportation were to be employed.

The Rocky Mountain oil province is a vast area. It is bounded on the north by the Canadian border; on the south by Texas, New Mexico and Arizona; on the east by the eastern half of North and South Dakota, Nebraska and Kansas; and on the west by the western half of Idaho and Nevada. The Rocky Mountain range trends northwesterly through almost half of the province and its higher peaks reach elevations of 10,000 to 14,000 feet. Oil and gas operations are scattered through the area.

The oil industry in this region has a transportation problem. Much of the area now under exploration is remote from cities and towns. There are numerous good highways, rail and air lines which criss-cross the area, and while they adequately serve general types of businesses, the time required to reach oil service centers becomes a serious matter particularly in the exploration operations. The principal oil field service and supply centers in this sprawling oil province of the Rocky Mountain area are Denver and Craig, Colo.; Casper, Rock Springs, Cody, Worland and Newcastle, Wyo.; Billings and Cut Bank, Mont.; Salt Lake City and Vernal, Utah; and Farmington, N. M.

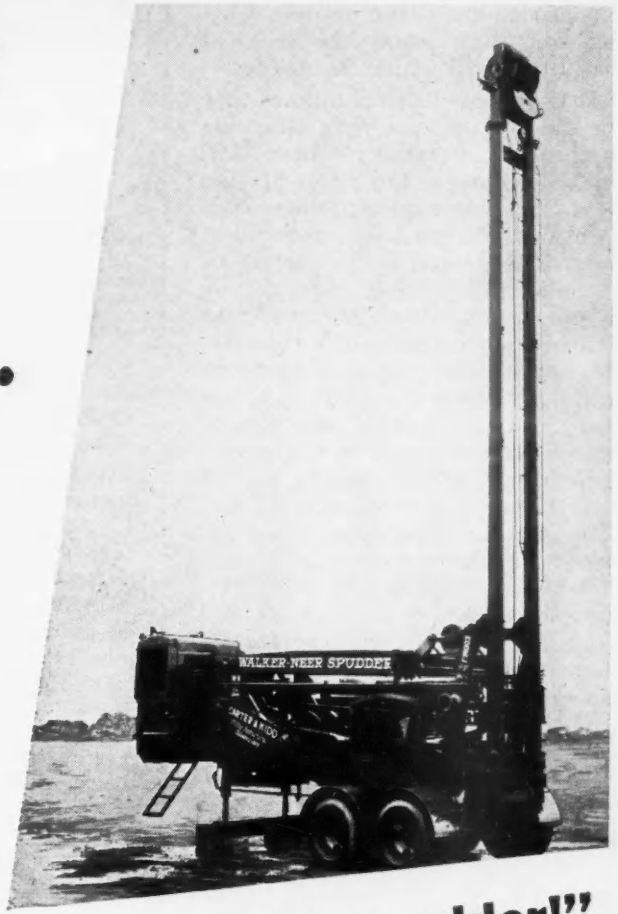
ECONOMIES IN exploratory drilling in the rugged Rocky Mountain region are afforded by a flying laboratory service. A light plane delivers well cores from remote wildcat sites to the laboratory at Casper, Wyo. Savings are made by reducing rig down time. Other advantages include the benefits of analyses made in a fully equipped, permanent laboratory.

Hundreds of miles of mountainous terrain separate these centers. Although these centers are served by air, rail and motor freight, time is money in drilling, and light plane service has proven fastest and most economical in the province for such operations. Servicing of drilling wells by light planes has been in vogue for a number of years, and laboratory services by plane have proven practical. Of particular importance to wildcat operations is that cores can be flown hundreds of miles within a few hours to a base laboratory, where the best of equipment can analyze and interpret results.

Reduced Rig Standby Time

Flying laboratory service originally was intended to transport cores from the well to the base laboratory for analysis, but other uses quickly developed. In one instance, for example, an engineer was wanted for a job that did not permit driving time to the location. A flying laboratory plane took him to the location. In another case, a wildcat well topped an unexpected sand, and a geologist

"They Knew What Cable Tool Men Want . . .



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NO STOPPAGES FOR LUBRICATION—All drums and sheaves are mounted on ball or roller bearings and ordinarily require no lubrication during the period of drilling a well.

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was needed immediately. Using a flying laboratory plane, the geologist was at the well within 90 minutes.

It is estimated that shutdown time for the average rotary rig operating in this area amounts to about $400 per day, equivalent to about $17 per hour. There are numerous times when core analysis, gas analysis or water analysis is desired before testing or resuming drilling and when the rig is put on standby time until the desired information can be secured. In most of these cases, transportation to the laboratory occupies more time than the actual analysis itself. Several ideas have been tried to circumvent these costly delays, but the cost of well site units often exceeds the cost of suspended operation, much depending upon the size of the rig and objective of the particular well. Flying laboratory service, reasonably priced, seems to be the best answer. Better work can be done in a base laboratory by the use of portable or semi-portable units. Portable units of necessity must sacrifice some degree of accuracy and reliability to convenience. While such sacrifice does not necessarily invalidate field results, it would be better if both accuracy and saving of time could be accomplished at the same time. Flying service is a step in this direction.

There is no operation in the Rocky Mountain province more than four hours by air from Casper, which is in approximately the geographic center of the region. A plane can fly over the mountains and can reduce mileage by direct line flying. A typical trip from Casper averages two hours flying time, while six to eight hours are required if traveled by road. Each hour of transportation saved is equivalent to an average of about $20 rig time, and the usual saving often runs from three to five hours. Some typical examples of flying time include: Newcastle to Casper, 1 hour; Rock Springs to Casper, 1½ hours; Grand Junction to Casper, 2½ hours; Sidney to Casper, 2½ hours, and Powell to Casper, 2½ hours. Wind conditions vary the time to some extent, and in general, easterly bearings are faster than westerly bearings.

Case Histories Reveal Savings

An actual case history that illustrates savings through use of flying service, as compared with highway travel, concerns transportation of some cores from a well in the Rock Springs, Wyo., area to Casper. The plane left Casper at 12 p.m., arrived at Rock Springs at 2 p.m., picked up the cores, and returned to Casper at 3:30 p.m. The cores were analyzed and the results reported back at 7 p.m. Cost to the operator for transporation was 344 miles at 12 cents per mile, or $41.28. At a later date, a number of cores were sent by automobile from Rock Springs at a cost of 7 cents per mile; the round trip was 788 miles; and the cost was $55.16. The elapsed time one way was six hours as against 1½ hours by plane. Mileage saved by plane transportation amounted to $13.88, plus rig time of $300.

In another instance, the town of Upton, Wyo., drilling for a domestic water supply, utilized plane service to reduce rig time. Standby time amounted to $100 per day. The sample was handled by flying laboratory service at a cost of $17.50 for transporation, and results were reported to the mayor within four hours after the sand was hit, saving an estimated 1½ days of standby time for the rig.

The light plane used for this service is a four-place ship capable of carrying about 600 pounds of cores and equipment when not occupied by passengers. Though not as fast as some light planes, it is rugged and capable of landing and taking off from roads, rough strips and small fields. Its cruising speed is 120 miles per hour, and it carries enough fuel to reach most points in the area without refueling. Cost of operation is such that rates can be held to a reasonable figure.

Many operators have found that flying laboratory service is the most efficient and inexpensive transportation available in the Rocky Mountain region when time is concerned. The air-mile charges, which barely cover operating expenses, are based upon CAA maps from Casper to location and return, regardless of deviations from the true compass course due to storms, mountains or other interference. Charges are based upon air miles, not hours in flight.

Rocky Mountain weather, in general, is excellent for contact flying, and bad weather usually is localized and can be avoided. There are days when it is impossible to fly, but fortunately such days are at a minimum. In one instance the plane failed to get to its destination at the designated time, weather conditions halfway to the destination having grounded it. A car immediately was sent out for the balance of the trip, however. Flying laboratory service has proven both practical and economical in this province of long distance and high mountains and has been accepted by the oil industry as a routine method of transportation where a saving of time is essential.

About the Author

JAMES E. CAMPBELL, service consultant with Chemical & Geological Laboratories, Casper, Wyo., received his formal education at the University of Oklahoma in petroleum engineering. He went to the Rocky Mountain region in 1936 as mud engineer and representative of Colox Sales & Service. With the merger of Colox with Baroid Sales Division, National Lead Company, he was transferred to the Gulf Coast, where he was employed both by the Mud Logging and Mud Sales divisions. He returned to the Rocky Mountain region as sales engineer for American Pipe and Supply Company. After wartime defense work, Campbell became associated with Security Engineering Company, following which he joined Chemical & Geological Laboratories at Casper.

DISTANCES FROM CASPER

Road-mile versus air-mile distances between Casper and some of the principal oil industry centers of operation in other parts of the Rocky Mountain region.

From Casper, Wyo., to:	Road Miles	Air Miles*
Cut Bank, Mont.	650	500
Roundup, Mont.	350	275
Elk Basin, Wyo.	361	190
Worland, Wyo.	168	115
Rock Springs, Wyo.	394	170
Newcastle, Wyo.	194	125
Riverton, Wyo.	123	110
Vernal, Utah	361	240
Rangely, Colo.	327	235
Durango, Colo.	565	390
Sterling, Colo.	314	220
Lamot, Colo.	502	380
Farmington, N. M.	615	430
Sidney, Neb.	265	210
Alliance, Neb.	239	185
Scottsbluff, Neb.	183	155
Rapid City, S. D.	274	180
Idaho Falls, Idaho	397	300

* To the nearest five miles

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Exploration 22.3 Percent Ahead of 1950 Period

EXPLORATORY drilling resulted in 965 wells being completed in November, of which 168 or 17.4 percent were rated as commercial producers. The month's activity boosted the year's 11-month total to 9736, which represented an increase of 22.3 percent over the 7964 completed in the comparable period of 1950. However, of this year's tests only 18 percent have been successful, while a year ago the score had been 19.1 percent.

A total of 108 new oil pools were discovered in the U. S. during November. Eighty-five of these were new oil fields and the remaining 23 were new oil horizons in established fields. A month earlier a comparable 102 new oil sources were uncovered. In the year so far, a total of 1196 new pools have been located, compared with 1005 in the first 11 months of last year. This year's finds were comprised of 886 new oil fields and 310 new oil pays.

The month's distillate discoveries numbered nine against six a month earlier. For the year new distillate pools totaled 78, which was slightly under the 81 recorded in 11 months of 1950.

Summary of Results of Exploratory Drilling

ITEM	Nov., 1951	Oct., 1951	ELEVEN MONTHS January-November 1951	1950	Percent Diff.
Oil Discoveries	108	102	1,196	1,005	+ 19.0
New Fields	85	82	886	737	+ 20.2
New Pays	23	20	310	268	+ 15.7
Distillate Discoveries	9	6	78	81	— 3.7
New Fields	8	2	53	64	— 17.2
New Pays	1	4	25	17	+ 47.1
Gas Discoveries	22	17	200	135	+ 48.1
New Fields	17	14	157	118	+ 33.1
New Pays	5	3	43	17	+152.9
Total Discoveries	139	125	1,474	1,221	+ 20.7
Extensions to Fields	29	22	274	303	— 9.6
Oil Fields	22	17	213	267	— 20.2
Distillate Fields	3	.....	17	12	+ 41.7
Gas Fields	4	5	44	24	+ 83.3
Total Prod. Tests	168	147	1,748	1,524	+ 14.7
Dry Holes	797	805	7,988	6,440	+ 24.0
Wildcats	773	772	7,645	6,172	+ 23.9
New Pays	1	1	13	8	+ 63.0
Outposts	23	32	330	260	+ 26.9
Total Expl'tory Tests	965	952	9,736	7,964	+ 22.3
Percent Productive	17.4	15.4	18.0	19.1	.....
Percent Dry	82.6	84.6	82.0	80.9	.....

Results of Exploratory Drilling in November and First 11 Months, 1951-1950 by Districts

State or District	MONTH OF NOVEMBER 1951													FIRST ELEVEN MONTHS, 1951																
	Productive Tests										Unproductive Tests				Productive Tests								Unproductive Tests			Total Dry		Total Exploratory Tests	
	New Fields			New Pays			Extensions			Total Productive				Total Exploratory Tests	New Fields			New Pays			Extensions			Total Productive						
	Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas		Wildcats	New Pays	Outposts		Oil	Dis.	Gas	Oil	Dis.	Gas	Oil	Dis.	Gas	11 Mo. 1951	11 Mo. 1950	Wildcats	New Pays	Outposts	11 Mo. 1951	11 Mo. 1950	11 Mo. 1951	11 Mo. 1950
Alabama											2			2				1			2			3	2	20		1	21	18	24	20
Arizona											1			1												4			4	8	4	8
Arkansas	1			1						2	8			10	5		1	10	1		3			20	12	80		8	88	77	108	89
California	1			5			3		1	10	34		6	50	28		2	27			16		4	77	49	398	4	41	443	353	520	402
Colorado	3		1							4	14		1	19	9		4			1				14	10	113		4	117	46	131	56
Florida																										3			3	8	3	8
Georgia																														4		4
Idaho																										1			1	5	1	5
Illinois	2		1	2			4			9	58			67	32		1	19		2	44			98	110	677			677	664	775	774
Indiana	2			1			1			4	29			33	36			11		1	3			51	51	383		1	384	442	435	493
Kansas	10									10	92			102	134		7	23						164	102	758			758	572	922	674
Kentucky	2						2			4	11			15	16			7			9			32	23	170			170	91	202	114
Louisiana	4				1	1		1		7	42		1	50	32	6	4	15	5	5	12	2	1	82	83	320	1	20	341	220	423	303
North Louisiana	3				1	1		1		6	29		1	36	18	1		4	2	5	6	2	1	39	30	207	1	10	218	116	257	146
South Louisiana	1									1	13			14	14	5	4	11	3		6			43	53	113		10	123	104	166	157
Maryland																							1							3		4
Michigan	2									2	25			27	11		4	1		1	1			18	39	292			292	280	310	319
Mississippi	1		1							2	24	1	1	28	12	2	1	4	2		1			22	14	145	1	11	157	130	179	144
Missouri																										1			1	6	1	6
Montana	1									1	6			7	2						4			6	5	46	1	5	52	55	58	60
Nebraska	1						1		2	4	9		2	15	11		1	1			3		6	22	11	76		8	84	54	106	65
Nevada																										2			2	2	2	2
New Mexico				1						1	5			6	13		9	5			3		2	32	28	68	1	7	76	70	108	98
New York																																
North Dakota											1			1	1									1		8			8		9	
Ohio											2			2				1			1		4	6	4	24			24	14	30	18
Oklahoma	7		2	3			1			13	68			81	72	3	10	23	2	1	29	2	2	144	149	619			619	476	763	625
Oregon																																
Pennsylvania																	1							1	1						1	1
South Dakota											2			2												2			2	7	2	7
Tennessee																										6			6	4	6	4
Texas	47	8	10	10		4	10	2	1	92	324		11	427	461	42	105	152	15	31	76	13	25	920	799	3295	5	208	3508	2706	4428	3505
Dist. 1 S. Central	3			2			1			6	26		2	34	21		4	4		1	6		1	37	22	201		15	216	190	253	212
Dist. 2 Middle Gulf	1	2	4	1		1	1	1		11	30		2	43	12	12	16	21	3	11	6	4	9	94	66	208	1	32	241	164	335	230
Dist. 3 Upper Gulf	2	1		3		1				7	20			27	21	10	24	32	2	4	2	1	2	98	105	246		7	253	229	351	334
Dist. 4 L Gulf-S.W.	7	4	3	2		1	1	1	1	20	41			61	30	10	22	34	7	10	8	2	9	132	97	343	1	30	374	273	506	370
Dist. 5 E. Central											7			7	5	2	1	6			7			21	9	134		3	137	66	158	75
Dist. 6 Northeast	1					1				2	6		1	9	7	4	1	3	1	1	1	6		24	22	85		4	89	78	113	100
Dist. 7-B N. Cent.	10		1							11	72		2	85	162		22	14		2	4		2	206	178	887		15	902	586	1108	764
Dist. 7-C W. Cent.	7		1				4			12	31			43	55	1	6	6	2		10			80	47	285		7	292	213	372	260
Dist. 8 West	8			2			2			12	29			41	61		4	15			18			98	126	337	3	13	353	298	451	424
Dist. 9 North	8	1	1							10	55		4	69	84	3	3	17		2	13		1	123	126	533		81	614	597	737	723
Dist. 10 Panhandle							1			1	7			8	3		2				1		1	7	1	36		1	37	12	44	13
Utah			1							1	4			5	2		1							3	2	25			25	15	28	17
Washington																														2		2
West Virginia			1							1				1			3							3		2			2		5	
Wyoming	1									1	12		1	14	9		2	11		1	6			29	29	107		16	123	108	152	137
Total U. S.	85	8	17	23	1	5	22	3	4	168	773	1	23	965	886	53	157	310	25	43	213	17	44	1748	1524	7645	13	330	7988	6440	9736	7964

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U. S. Oil, Distillate and Gas Discoveries and Extensions in November

ARKANSAS—NEW OIL FIELD

Miller County. Skelly Oil Company's Agnes Philyaw 1, C NW NW SW 20-16s-26w, pumped 23 barrels oil and 8 barrels water from Paluxy sand, Lower Cretaceous 3554-3560 feet, 30-gravity, completed 11-11-51, TD 5840.

ARKANSAS—NEW OIL PAY

Union County, Lawson field. Marine Oil Company's Urbana Lumber Company 2, C NW SW NE 6-18s-13w, flowed 31 barrels from 2925-33 feet, 15/64-inch, completed 11-5-51, TD 3192.

CALIFORNIA—NEW OIL FIELD

Ventura County. Union Oil Company's Weldon Canyon Core Hole 1 (OWWO), in 3-3n-23w, pumped 82 barrels from 2895-3063 feet, 27.9-gravity, completed 10-23-51, TD 4816.

CALIFORNIA—NEW OIL PAYS

Kern County, McDonald Anticline field. Superior Oil Company's Theta 43-20, in 20-28s-20e, pumped 50 barrels from Tolco sand, 2611-39 feet, 19-gravity, completed 11-8-51, TD 2639.

Mountain View, East field. Humble Oil & Refining Company's Westberg 1-E, in 34-30s-29e, pumped 104 barrels from Chanac sand, Upper Miocene 4157-4551 feet, 24.5-gravity, completed 11-19-51, TD 4554.

Tejon Hills field. Steele Petroleum Company's Steel-Petroleum Rocco 2 (OWWO), in 25-12n-19w, pumped 10 barrels from 590-620 feet, 10-gravity, completed 10-3-51, TD 648.

Los Angeles County, Oat Mountain field. Edwin W. Pauley's Biou 36 (OWWO), in 19-3n-16w, pumped 300 barrels from Eocene sand, Eocene 9300-68 feet, 19.2-gravity, completed 11-9-51, TD 9525.

Orange County, Newport, West field. DeWitt Langford's Oka 1, in 18-6s-10w, pumped 180 barrels from Middle Pico sand, Pliocene 2015-50 feet, completed 11-10-51, TD 5296.

CALIFORNIA—OIL FIELD EXTENSIONS

Kern County, Arvin, North field. The Texas Company's Kern Valley 1, in 15-31s-29e, 1-mile northwest extension, pumped 12 barrels from 6275-6320 feet, 33.6-gravity, completed 11-9-51, TD 6462.

Kern County, Belgian Anticline field. The Ohio Oil Company's Tulare Fee 1, in 19-30s-22e, ½-mile northwest extension, flowed 42 barrels from Oceanic sand, Oligocene 6045-75 feet, 37-gravity, completed 11-15-51, TD 6971.

Comanche Point field. Mitchell G. Kovaleski's Black Gold 1, in 32-12n-18w, ½-mile southeast extension, pumped 50 barrels from 542-604 feet, 18-gravity, completed 11-13-51, TD 604.

CALIFORNIA—GAS FIELD EXTENSION

Yolo County, Winters field. Mohawk Petroleum Corporation's Winters Commission 8-1, in 13-8n-1w, ⅔-mile north extension, flowed 5.4-million from McCune sand, Cretaceous 4770-4800 feet, 25/64-inch, completed 11-22-51, TD 5010.

COLORADO—NEW OIL FIELDS

Morgan County. Shell Oil Company's C. E. Williams 1, NW NW SE 30-5n-60w, pumped 32 barrels from Dakota sand, Cretaceous 6526-33 feet, completed 11-30-51, TD 6953.

Weld County, "Greasewood" field. Gifford C. Parker & J. G. Dyer's Kirchof 2, C SE NW 12-6n-61w, flowed 684 barrels from Dakota "D" sand, Cretaceous 6750-62 feet, ½-inch, TD 6800.

Unnamed field. Wycolo Oil & Development Company's Patented 1, C SE 4-9n-61w, pumped 32 barrels from Upper "J" sand, Cretaceous 7322-65 feet, TD 7404.

COLORADO—NEW GAS FIELD

Garfield County. Greenbrier Oil Company & Mendota Oil Company's Government 1, C NW SW 24-5s-102w, flowed 7.7-million from Basal Morrison & Upper Entrada sands, Jurassic 7135-55 feet, completed 11-1-51, TD 8904.

ILLINOIS—NEW OIL FIELDS

Richland County, Ritter, North field. Sanders & Fye's Phillips 1, SW 18-3n-11e, pumped 52 barrels oil and 10 barrels water from McClosky lime, Mississippian 3200-07 feet, completed 11-13-51, TD 3288.

Wayne County, Goldengate, East field. C. E. Brehm's P. J. Seifert 1, NW NW SE 2-3s-9e, pumped 29 barrels oil and 35 barrels water from Lower O'Hara lime, Mississippian 3291-96 feet, completed 11-13-51, TD 3420.

ILLINOIS—NEW OIL PAYS

Marion County, Langewisch-Kuester field. W. C. Wellman's Langewisch 1, NE SW NE 4-1n-1e, pumped 2 barrels oil and 6 barrels water from Pennsylvania sand, Pennsylvanian 798-810 feet, completed 11-6-51, TD 824.

Wayne County, Half Moon field. Collins Brothers Oil Company's Mabee 2-B, NE SE SE 28-1s-9e, pumped 9 barrels oil and 24 barrels water from Aux Vases sand, Mississippian 3190-3210 feet, completed 11-20-51, TD 3310.

ILLINOIS—OIL FIELD EXTENSIONS

Jasper County, Ste. Marie, West field. Bell Brothers' C. Rudd 1, NE NW NE 2-5n-10e, ½-mile south extension, pumped 228 barrels from McClosky lime, Mississippian 2847-61 feet, completed 11-27-51, TD 2870.

Jefferson County, Divide, East field. Perrine & Perrine's L. C. Ellis 1, NW NW NE 30-1s-4e, ¾-mile southwest extension, pumped 27 barrels oil and 10 barrels water from Aux Vases sand, Mississippian 2671-77 feet, completed 11-20-51, TD 2677.

Reservoir field. National Associated Petroleum Company's Pfeiffer 1-A, NE NE NE 29-1s-3e, ½-mile northwest extension, pumped 136 barrels from McClosky lime, Mississippian 2574-78 feet, completed 11-27-51, TD 2585.

White County, Carmi, North field. E. F. Moran, Incorporated's J. Zimmerman 1, SW SW NW 10-5s-9e, ¾-mile south extension, pumped 20 barrels oil and 2 barrels water from Cypress sand, Mississippian 2948-65 feet, completed 11-20-51, TD 2966.

ILLINOIS—NEW GAS FIELD

Madison County, Livinston, East field. J. S. Lehwald's T. Voyles 1, SE SW NW 26-6n-6w, flowed 4.5-million from Pennsylvania sand, Pennsylvanian 543-555 feet, completed 11-27-51, TD 555.

INDIANA—NEW OIL FIELDS

Posey County. Peak Drilling Company's George Felthaus 1, NE NE NW 2-6s-12w, pumped 132 barrels oil and 40 barrels water from O'Hara lime, Mississippian 2630-38 feet, TD 2662.

Unnamed field. Ryan Oil Company's Carmen Flesher Commission 1, NW SE NE 29-6s-14w, pumped 7 barrels oil and 6 barrels water from Aux Vases lime, Mississippian 2783-90 feet, TD 2792.

INDIANA—NEW OIL PAY

Knox County, Iona field. Cline-Lambert Drilling Company's Roy Pea 1, Mil Don 41-2n-10w, pumped 10 barrels from Aux Vases lime, Mississippian 1711-16 feet, TD 1825.

INDIANA—OIL FIELD EXTENSION

Posey County, La Mott field. Stanford Oil Company's Oscar Oeth 1, NW NW SE 25-7s-13w, ½-mile west extension, pumped 20 barrels from McClosky lime, Mississippian 2670-76 feet, TD 2771.

KANSAS—NEW OIL FIELDS

Barton County, Harrison field. Grant Oil Company's Harrison 1, NW NW NW 18-20s-13w, flowed 125 barrels from Arbuckle lime, Ordovician 3501-50 feet, TD 3550.

Putnam field. Rocket Drilling Company's Putnam 1, NW NW NW 7-17s-13w, pumped 212 barrels oil and 9 barrels water from Lansing-KC lime, Pennsylvanian 3286-93 feet, TD 3492.

Cowley County. Smitherman & Cohen's McKay 1, SE SE NW 17-35s-4e, pumped 138 barrels from Bartlesville sand, Pennsylvanian 3314-25 feet, TD 3325.

Ellis County. Francis Oil & Gas Company's Fischer 1, SW SW NW 5-11s-20w, pumped 120 barrels from Arbuckle lime, Ordovician 3668-72 feet, TD 3682.

Gove County, Jasper field. Herndon Drilling Company et al's Jasper 1, NE NE NE 30-15s-29e, pumped 41 barrels from Lansing-KC lime, Pennsylvanian 3670-73 feet, TD 4324.

Graham County, Harmony field. Sitring & Murfin Drilling Company's Morris 1, SE SE SE 32-7s-22w, potentialed 1068 barrels from Lansing-KC lime, Pennsylvanian 3597-3600 feet, TD 3786.

Millbrook field. Peel & Hardman Drilling Company's Legere 1, NW NW SE 21-8s-23w, pumped 306 barrels from Lansing-KC lime, Pennsylvanian 3761-67 feet, TD 4080.

Worcester field. V. D. Sidey's Worcester 1, NW NW NW 23-7s-22w, pumped 237 barrels from Arbuckle lime, Ordovician 3791-98 feet, TD 3798.

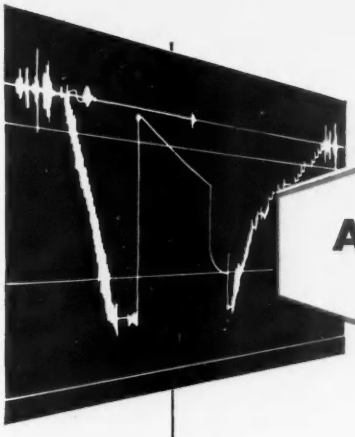
Kingman County, Spivey field. Iron Drilling Company's Boyle 1, SW NE NW 23-30s-8e, pumped 270 barrels from Mississippi lime, Mississippian 4238-60 feet, TD 4755.

Sedgwick County. Drillers Producing Company's Petrie 2, NE SW NW 35-26s-1w, pumped 30 barrels from Viola lime, Ordovician 3450-53 feet, TD 3466.

KENTUCKY—NEW OIL FIELDS

Webster County. Basin Oil Company's Luther Royster 2, in 7-N-24, swabbed 120 barrels from McClosky lime, Mississippian 2557-61 feet, TD 2570.

Onton, North field. Ralph Halbert &



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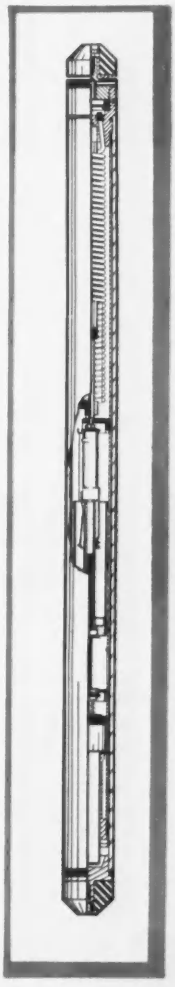

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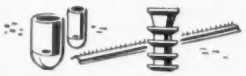

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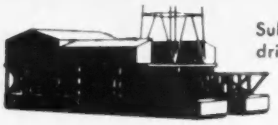

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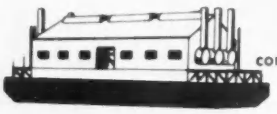

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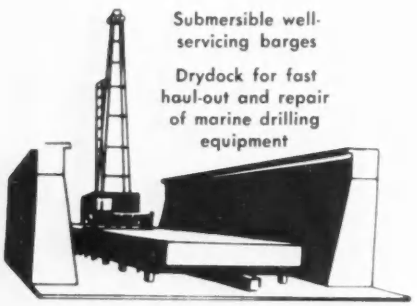

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William D. Jennings' M. L. Hartford 1, in 1-M-25, pumped 154 barrels from Tar Springs sand, Mississippian 1971-82 feet, TD 1982.

KENTUCKY—OIL FIELD EXTENSIONS

Henderson County, Hitesville, Consolidated field. John N. Partin & E. B. Martindale's W. C. Cavins 2, SE SE SE 15-P-21, ½-mile west extension, pumped 175 barrels from McClosky lime, Mississippian 2572-78 feet, TD 2587.

McLean County, Comer field. Sun Oil Company's Con Hinton 1, in 8-N-25, 1-mile extension, pumped 140 barrels from Waltersburg sand, Upper Mississippian 1574-90 feet, TD 1590.

NORTH LOUISIANA—NEW OIL FIELDS

Concordia Parish. Barnett Serio's R. S. Wilds Sr. 1, C SW SW 7-7n-7e, pumped 19 barrels from Wilcox sand, Eocene 5131-32 feet, 39.8-gravity, completed 11-27-51, TD 5515.

Cocodrie Bayou field. Hunt Oil Company's F. F. Yakey et al 1, C SE NW 29-4n-8e, pumped 100 barrels from Wilcox sand, Eocene 6944-48 feet, 45.5-gravity, completed 10-13-51, TD 7500.

Cocodrie Bayou, West field. Hunt's F. F. Yakey et al 2, C SE SW 42-4n-8e, pumped 82 barrels from Wilcox sand, Eocene 6552-56 feet, completed 11-12-51, TD 7500.

NORTH LOUISIANA—NEW DISTILLATE PAY

Webster Parish, Sibley field. Atlantic Refining Company's Phillip Holley 1, in 25-18n-92, flowed 3 barrels and 3.4-million from Pettit lime, Lower Cretaceous 6766-84 feet, 55-gravity, ¼-inch, and 10 barrels and 3.1-million from Travis Peak lime, Lower Cretaceous 8570-88 feet, 52.2-gravity, ¼-inch, completed 11-7-51, TD 10,863.

NORTH LOUISIANA—DISTILLATE FIELD EXTENSION

Bossier Parish, Cotton Valley field. A. J. Hodges Incorporated's Pardee et al 1, in 26-21n-11w, 1-mile west extension, no gauge taken from Davis sand, Upper Jurassic 8858-78 feet, completed 11-7-51, TD 9550.

NORTH LOUISIANA—NEW GAS PAY

Bossier Parish, Elm Grove field. Otis D. Coston's Jack Caplis 2, in 22-16n-12w, flowed 0.2-million from 4440-4500 feet, completed 11-10-51, TD 4500.

SOUTH LOUISIANA—NEW OIL FIELD

Terrebonne Parish. Humble's LL&E D-1, in 32-19s-20e, flowed 206 barrels from 13,231-234 feet, 34.6-gravity, ⅛-inch, completed 11-29-51, TD 13,678.

MICHIGAN—NEW OIL FIELDS

Newaygo County. McClure Oil Company's Johnson 1, NW SE NW 25-12n-14w, Sheridan township, flowed 45 barrels from Traverse lime, Devonian 2204-05 feet, TD 2205.

Osceola County, Minerals Springs field. Mogul Oil Company's Hammar 1, SW SW NE 20-20n-9w, flowed 12 barrels from Dundee lime, Devonian 3861-69 feet, TD 3872.

MISSISSIPPI—NEW OIL FIELD

Franklin County, "Knoxville Tower" field. Hunt's U. S. A. 1, in 20-5n-2e, flowed 100 barrels from Wilcox sand, Eocene 6465-69 feet, ¼-inch, completed 11-12-51, TD 11,190.

MISSISSIPPI—NEW GAS FIELD

Adams County. Austin E. Stewart et al's F. M. McGehee 1, in 41-8n-1w, flowed 1.5-million from Sparta sand, Eocene 3001-03 feet, ¼-inch, completed 11-29-51, TD 6516.

MONTANA—NEW OIL FIELD

Rosebud County. The Texas Company's Bertha M. Horgen 1, C SE NW 13-11n-32e, pumped 136 barrels from Basal Amsden sand, Pennsylvanian 4770-85 feet, completed 11-23-51, TD 5657.

NEBRASKA—NEW OIL FIELD

Kimball County, Enders field. Rock Hill Oil Company & Twin Oil Company's Enders 1, NE NW SE 15-13n-55w, flowed 1160 barrels from "J" sand, Cretaceous 6306-6332 feet, completed 11-12-51, TD 6332.

NEBRASKA—OIL FIELD EXTENSION

Cheyenne County, Dalton field. Olds Oil Corporation's Laing 1, SW SW NE 32-17n-49w, 1½-mile east extension, pumped 75 barrels from Muddy sand, Cretaceous 4669-72 feet, completed 11-12-51, TD 4734.

NEBRASKA—GAS FIELD EXTENSIONS

Deuel County, Big Springs field. Ohio's Troelstrup Livestock 1, C SE 35-13n-43w, 1-mile southwest extension, flowed "D" sand, Cretaceous 3214-18 feet, flowed 4-million, completed 11-16-51, TD 3344.

Big Springs, North field. Charles D. Edmonson et al's Louis M. Vance 1, SW NW NE 8-13n-42w, 1-mile north extension, flowed 15-million from "D" sand, Cretaceous 3326-32 feet, completed 11-28-51, TD 3390.

NEW MEXICO—NEW OIL PAY

Lea County, Hobbs, East field. Aurora Gasoline Company's Davis 1, in 29-18s-39e, flowed 720 barrels from San Andres lime, Permian 4449-65 feet, 30.8-gravity, ½-inch, completed 10-13-51, TD 4465.

OKLAHOMA—NEW OIL FIELDS

Logan County. O'Rourke-Baker Drilling Company's Wallace 1, SW SW SW 22-17n-1e, flowed 136 barrels from 2nd Wilcox sand, Ordovician 5106-10 feet, 47-gravity, 3/16-inch, TD 5110.

Osage County. Forrest H. Lindsay's Osage 1, NE NE NE 6-23n-10e, pumped 136 barrels oil and 25 barrels water from Bartlesville sand, Pennsylvanian 2129-50 feet, 36-gravity, TD 2172.

Payne County. Foster Drilling Company's Pence 2, SW NW NE 21-18n-6e, flowed 44 barrels from Red Fork sand, Pennsylvanian 3042-68 feet, 37-gravity, open, TD 3068.

Unnamed field. Tom G. Prior's Vincent 1, NE NW NW 23-20n-4e, pumped 30 barrels from Misener sand, Mississippian 3964-68 feet, TD 3971.

Unnamed field. Wilcox Oil Company, Amerada Petroleum Corporation & Cities Service Oil Company's Sam Lee 1, NE NE SW 10-18n-2e, pumped 30 barrels from Lower Skinner sand, Pennsylvanian 4302-16 feet, 40-gravity, TD 4950.

Pottawatomie County. Wood Oil Company's Brant 1 (OWDD), SE NE SW 18-10n-5e, pumped 18 barrels oil and 100 barrels water from Simpson dolomite, Ordovician and 1st Wilcox sand, Ordovician 4751-4802 feet, TD 4802.

Stephens County. Shell's E. Tugman 1, NE SW NE 11-2n-8w, flowed 95 barrels from Tugman sand, Pennsylvanian

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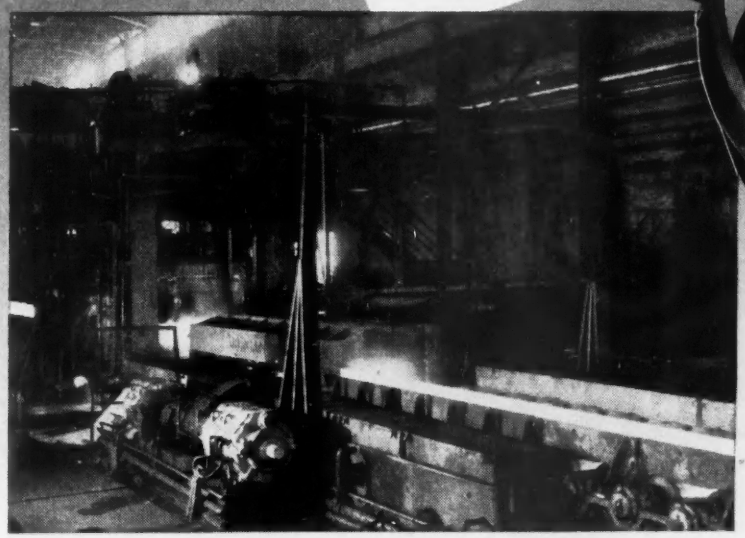

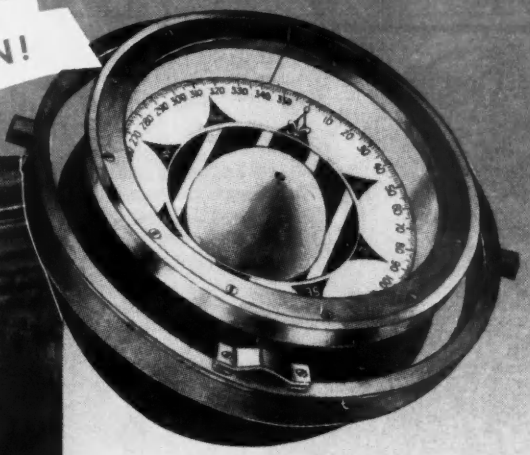

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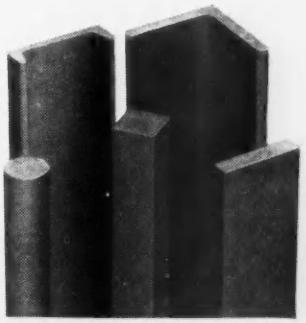

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6072-85 feet, and Atkins sand, Pennsylvanian 7570-91 feet, ¾-inch, TD 10,006.

OKLAHOMA—NEW OIL PAYS

Cleveland County, Moore field. Sinclair Oil & Gas Company's Community Franklin 5-A, C NE SE 21-10n-2w, flowed 824 barrels from McLish sand, Ordovician 7639-99 feet, 38-gravity, ¾-inch, TD 8295.

Moore, South field. Mid-Continent Petroleum Corporation's E. P. Westermier 1 (OWDD), NE SW SW 26-10n-3w, flowed 401 barrels from Joins sand, Ordovician 9578-94 feet, 38-gravity, 9/32-inch, TD 9630.

Noble County, Sams, North field. Bay Petroleum Corporation's Hugo Bolzinger 1, NW NW NW 18-21n-1w, pumped 60 barrels oil and 20 barrels water from Avant lime, Pennsylvanian 3374-94 feet, 42-gravity, TD 5098.

OKLAHOMA—OIL FIELD EXTENSION

Carter County, Brock, West field. Ward S. Merrick et al's Hattie Brown 1, NE NE SE 8-5s-1w, ½-mile northwest extension, pumped 84 barrels oil and 3 barrels water from 4184-90 feet, 34.6-gravity, TD 4509.

OKLAHOMA—NEW GAS FIELDS

Lincoln County. Sinclair's Gladys Tansel 1, NE NE SW 8-14n-2e, flowed 1.8-million from Checkerboard sand, Pennsylvanian 3752-72 feet, ⅜-inch, TD 5344.

Osage County. Johnson Oil & Refining Company's Osage 2, SE SE NW 17-22n-8e, flowed 6-million from Oswego lime, Pennsylvanian 2143-54 feet, open, TD 2154.

TEXAS DISTRICT 1—NEW OIL FIELDS

Atascosa County, Guy Smith field. B. F. Usery's Guy Smith 1 (OWWO), William Waggoner Survey, pumped 129 barrels from Queen City sand, Eocene 2205-07 feet, 21-gravity, completed 11-14-51, TD 2207.

Frio County. George W. Graham's T. P. Nowlin 1, John W. Crawford Survey, pumped 22 barrels oil and 3 barrels water from Olmos B sand, Upper Cretaceous 3410-75 feet, 40-gravity, completed 9-24-51, TD 3475.

Gonzales County, "Stulting" field. O. Neathery, Junior's Stulting 1, Robert Kelly Survey, flowed 35 barrels from Carrizo sand, Eocene 2036-46 feet, 21.8-gravity, 9/64-inch, completed 10-19-51, TD 2046.

TEXAS DISTRICT 1—NEW OIL PAYS

Atascosa County, Jourdanton field. Magnolia Petroleum Company's Nixon & Steinle 3, John Neill Survey, pumped 9 barrels from Queen City sand, Eocene 785-93 feet, 19.3-gravity, completed 10-22-51, TD 824.

Wilson County, Borregas Creek field. Martin, Shelly, Thomas, Wise, McCabe & Olmos' Higgins 2, Rafael Salinas Survey, flowed 438 barrels from Buda lime, Upper Cretaceous 5700-38 feet, 22.8-gravity, ½-inch, completed 10-30-51, TD 6004.

TEXAS DISTRICT 1—OIL FIELD EXTENSION

Frio County, Big Foot field. Shell's Dennis Thompson 1, Rusk Transportation Survey, 1½-mile east extension, pumped 2 barrels oil and 2 barrels water from 3489-3570 feet, completed 11-2-51, TD 3866.

TEXAS DISTRICT 2—NEW OIL FIELD

Live Oak County, "Sheriff Smith" field. Sunray Oil Corporation's W. A. Smith 1, T. B. Reese Survey, flowed 53 barrels from Mackhank sand, Eocene 7030-40 feet, 33.2-gravity, ¼-inch, completed 10-26-51, TD 7548.

TEXAS DISTRICT 2—NEW OIL PAY

Jackson County, Francitas field. The Texas Company's Ethel M. Beckenhauer 1, R. D. Moore Survey, flowed 55 barrels from 7377-80 feet, 44.8-gravity, ⅛-inch, completed 11-11-51,TD 8000.

TEXAS DISTRICT 2—OIL FIELD EXTENSION

Refugio County, Refugio field. Sam E. Wilson, Junior's Jamie Hynes C-1, Manuel Arocha Survey, ⅝-mile southwest extension, flowed 65 barrels from 4651-56 feet, 11/64-inch, completed 11-10-51, TD 6493.

TEXAS DISTRICT 2—NEW DISTILLATE FIELDS

Calhoun County. C. G. Glasscock's F. A. Street 1, Casillas S. Paschall & J. J. Ogsberry Survey, flowed 129 barrels from 5773-80 feet, ⅛-inch, completed 10-7-51, TD 5895.

DeWitt County. Magnolia's Anna Sinast 1, Henry Clark League, flowed distillate and 5-million from Slick sand, Eocene

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Out in Front

$13,051,022 more in written premiums for 1950 than the nearest competitor. This chart, shown in millions of dollars, is based on figures furnished by the Texas Board of Insurance Commissioners. It graphically compares the premium of the ten principal writers of Workmen's Compensation in Texas last year. According to these figures, Texas Employers' Insurance Association wrote $15,336,991, over one-fourth of all Workmen's Compensation premiums for the year, in competition with some 130 companies.

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HOME OFFICE - DALLAS, TEXAS

7343-59 feet, 56.3-gravity, open, completed 10-24-51, TD 7463.

TEXAS DISTRICT 2— DISTILLATE FIELD EXTENSION

Goliad County, Boyce field. Continental Oil Company's Emil Els 1, CCSD & RGNG RR Co. Survey, ½-mile west extension, flowed 48 barrels and 1.7-million from Slick sand, Eocene 7489-7509 feet, ¼-inch, completed 11-27-51, TD 7650.

TEXAS DISTRICT 2— NEW GAS FIELDS

Goliad County. Dallas Husky's J. Fell 2, Sampson McTornall Survey, no gauge from 203-40 feet, completed 9-1-51, TD 2950.

Live Oak County. Lee Brothers Oil Company's Clyde Boothe 1, M. B. Kivlin Survey, flowed 3.1-million from 3270-80 feet, open, completed 11-16-51, TD 4200.

Refugio County. C. L. Norsworthy, Junior's T. C. Holeman 1-A, Michael Reilly Survey, flowed 8-million from 2048-54 feet, open, completed 10-20-51, TD 2063.

Victoria County, Aloe field. G. W. McCarter's Alex Angerstein 1, Zepeda Grant, flowed 20-million from 2200-4300 feet, open, completed 9-16-51, TD 4300.

TEXAS DISTRICT 2— NEW GAS PAY

Goliad County, Gladys Powell field. Sunray's Mrs. Imogene Ray Hall 1, Vincente Ramon Survey, flowed 8-million from Luling sand, Eocene 7762-73 feet, open, completed 11-8-51, TD 8433.

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TEXAS DISTRICT 3— NEW OIL FIELDS

Grimes County. Woodley Petroleum Company & Stanolind's Iris Clark et al 1, Wesley Fisher Survey, flowed 21 barrels from Upper Wilcox sand, Eocene 4688-92 feet, 35-gravity, 12/64-inch, completed 9-21-51, TD 8198.

Harris County. Amerada Petroleum Corporation's Linda F. West 1, Thomas Hogan Survey, flowed 85 barrels from 7495-7500 feet, 36.4-gravity, 5/32-inch, completed 11-8-51, TD 7922.

TEXAS DISTRICT 3— NEW OIL PAYS

Colorado County, Hamel field. Rex Cauble's J. F. Walker 1, J. E. Smith Survey, flowed 42 barrels from Upper Wilcox sand, Eocene 6670-80 feet, 38-gravity, ¼-inch, completed 10-24-51, TD 10,428.

Liberty County, South Dayton field. The Texas Company's William Duncan Welder et al 1, William Duncan Survey, flowed 254 barrels from 8945-47 feet, 35.3-gravity, 5/32-inch, completed 11-23-51, TD 10,004.

Wharton County, Boling Dome field. Michael T. Halbouty et al's Gary Estate 1-A, Seth Ingram Survey, flowed 169 barrels from Frio "4" sand, Oligocene 6834-40 feet, 26.4-gravity, 9/64-inch, completed 11-25-51, TD 7213.

TEXAS DISTRICT 3— NEW DISTILLATE FIELD

Chambers County. Standard Oil Company of Texas' W. F. Gau 1, John S. Roberts Survey, flowed 74 barrels and 1.5-million from Frio sand, Oligocene 8272-76 feet, 55-gravity, 5/32-inch, completed 11-16-51, TD 9047.

TEXAS DISTRICT 3— NEW GAS PAY

Brazoria County. Unnamed field. Brazos Oil & Gas Company's J. L. Ducroz 2, Calvin Summells Survey, no gauge from 3932-46 feet, completed 11-12-51, TD 4508.

TEXAS DISTRICT 4— NEW OIL FIELDS

Aransas County. C. G. Glasscock & Pontiac Refining Company's State 48-1, State Tract 48, Copano Bay, flowed 140 barrels from 6295-6300 feet, 40.5-gravity, ⅛-inch, completed 11-6-51, TD 8194.

Jim Hogg County. H. L. Hunt's Lawrence R. Brooks 1, Block 6, Santo de Abajo Grant, flowed 146 barrels from Cole sand, Eocene 3673-77 feet, 48-gravity, ⅜-inch, completed 10-25-51, TD 4721.

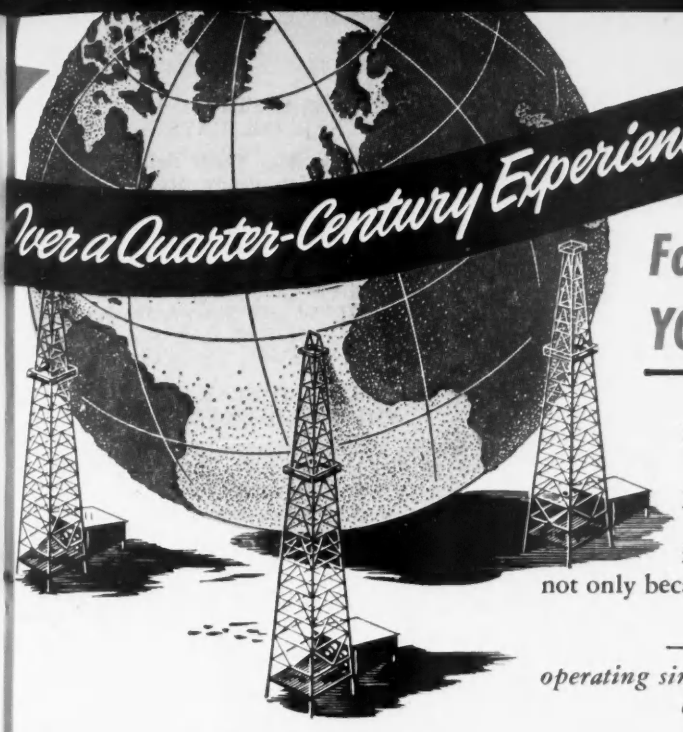
Jim Wells County. Barron Kidd's M. E. Dilworth 1, S. A. & MGRR Survey, flowed 52 barrels from 5018-23 feet, 9/64-inch, 41.4-gravity, completed 10-22-51, TD 5084.

Nueces County. Stanolind's State Tract 414-1, Corpus Christi Bay, pumped 55 barrels oil and 137 barrels water from 8002-14 feet, completed 11-21-51, TD 8309.

Unnamed field. Stanolind's State Tract 416-1, Corpus Christi Bay, flowed 169 barrels from 8310-20 feet, 5/32-inch, completed 11-29-51, TD 8400.

Unnamed field. Stanolind's State Tract 421-1, Corpus Christi Bay, flowed 203 barrels oil and 23 barrels water from 7285-90 feet, 44-gravity, 9/64-inch, completed 8-28-51, TD 9521.

Starr County. George E. Wrather Oil Company & Bass & Vessels' Hilaria A. DeGarza 1, Santa Cruz Grant, flowed 66 barrels from 5941-52 feet, 45.3-gravity, ⅛-inch, completed 11-26-51, TD 6509.



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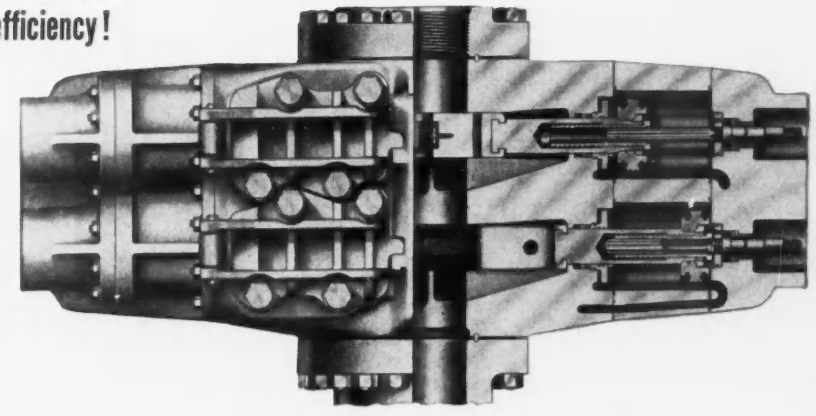

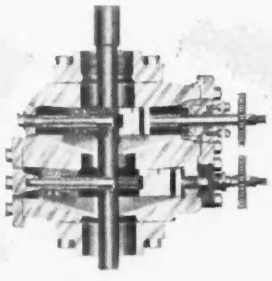

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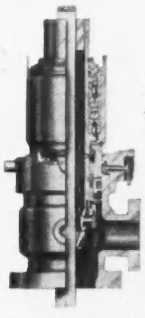

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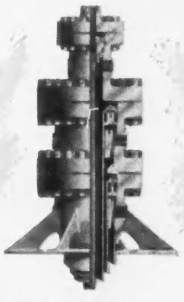

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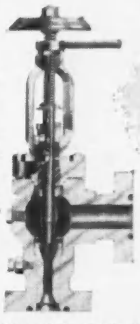

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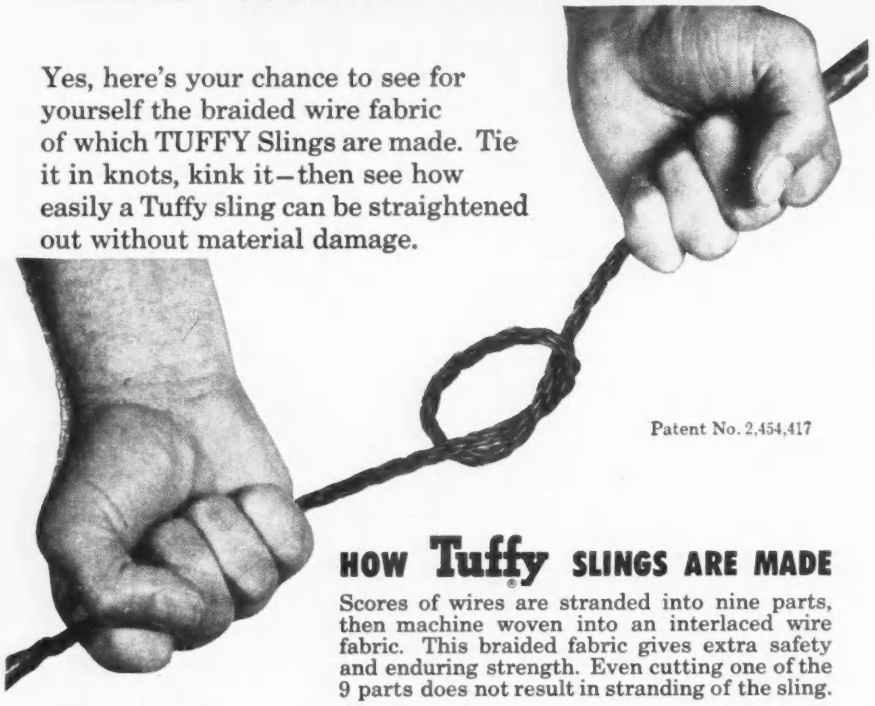

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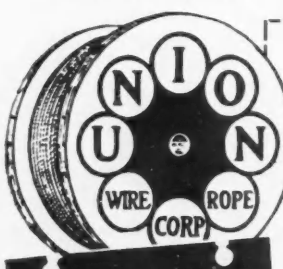

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TEXAS DISTRICT 4— NEW OIL PAYS

Brooks County, Alta Verde field. Howeth & Mason's Mrs. Emily McLeod 1, S. Alacon Survey, pumped 55 barrels from 2186-92 feet, 28-gravity, completed 10-29-51, TD 3894.

San Patricio County, Portilla field. Plymouth Oil Company's R. H. Welder 3-G, E. H. Welder Survey, flowed 306 barrels from 7118-25 feet, 40.4-gravity, completed 11-27-51, TD 8214.

TEXAS DISTRICT 4— OIL FIELD EXTENSION

Nueces County, Mustang Island field. Atlantic Refining's State Tract 435-1, Corpus Christi Bay, 1-mile south extension, flowed 168 barrels from Frio sand, Oligocene 7289-96 feet, 43.1-gravity, ⅛-inch, completed 10-6-51, TD 7999.

TEXAS DISTRICT 4— NEW DISTILLATE FIELDS

Hidalgo County. Continental's P. H. Longoria et al 2, San Ramon Grant Survey, flowed 146 barrels and 4-million from 8837-42 feet, 3/16-inch, completed 11-6-51, TD 8950.

Nueces County. Aransas Dock & Channel Company's Fee 1, Survey 652, flowed 35 barrels and 7-million from 7295-7311 feet, ¼-inch, completed 10-18-51, TD 8650.

Unnamed field. Atlantic Refining's C. J. Horne 1, Section 24, R. de Ynojosa Survey, flowed 65 barrels and 2.2-million from 9880-9910 feet, 50.2-gravity, ¼-inch, completed 10-20-51, TD 10,300.

Unnamed field. Sam E. Wilson, Junior & Renwar Oil Corporation's State of Texas Tract 462-A-1, Corpus Christi Bay, flowed 26 barrels and 2.4-million from 8453-55 feet, 59-gravity, completed 9-7-51, TD 10,718.

TEXAS DISTRICT 4— DISTILLATE FIELD EXTENSION

Nueces County, Mustang Island field. Atlantic Refining's State Tract 426-1, State Tract 426, Corpus Christi Bay, ⅝-mile northwest extension, flowed 20 barrels and 4-million from Frio sand, Oligocene 7120-40 feet, completed 11-15-51, TD 8499.

TEXAS DISTRICT 4— NEW GAS FIELDS

Nueces County. Atlantic Refining's State 411-1, Red Fish Bay, flowed 4-million from 7130-80 feet, completed 10-10-51, TD 8500.

Starr County. The Chicago Corporation's Slick Estate 16, Los Maguelles Grant, flowed 1.9-million from Maguelles sand, Oligocene 4761-64 feet, 7/32-inch, completed 9-24-51, TD 5000.

Zapata County. Earl A. Thompson's M. Garza 2, Survey 284, flowed 4.9-million from 1665-70 feet, open, completed 8-25-51, TD 1675.

TEXAS DISTRICT 4— NEW GAS PAY

Nueces County, Flour Bluff, East field. Humble's East Flour Bluff St. 2-F, Laguna Madre Bay State Tract 31, flowed 33-million from Frio sand, Oligocene 8730-45 feet, open, completed 11-7-51, TD 9298.

TEXAS DISTRICT 4— GAS FIELD EXTENSION

Nueces County, White Point, East field. Phillips Petroleum Company's Plymouth-State of Texas 1, State Submerged

Lands Tract 690, ¾-mile south extension, flowed 1-million from 2777-82 feet, ⅛-inch, completed 10-11-51, TD 6500.

TEXAS DISTRICT 6— NEW OIL FIELD

Rusk County, "Stegall" field. H. A. Clarke & V. B. Stone's Kangerga Brothers 1, W. R. Moore Survey, flowed 84 barrels from Woodbine sand, Cretaceous 3817-25 feet, 35.6-gravity, ¼-inch, completed 11-27-51, TD 3825.

TEXAS DISTRICT 6— NEW GAS PAY

Harrison County, Scottsville field. Arkansas-Louisiana Gas Company's Mrs. Florence Akin 1, J. Chissum Survey, flowed 20-million from Pettit lime, Lower Cretaceous 6020-41 feet, open, completed 11-30-51, TD 6550.

TEXAS DISTRICT 7-C— NEW OIL FIELDS

Crockett County. Otto Engel & C & E Drilling Company's Halff 1, (OWWO), Section 52, Block 1, I&GN Survey, pumped 33 barrels from Queen sand, Permian 1679-1820 feet, 32-gravity, completed 11-15-51, TD 1820.

Reagan County. Paul F. Barnhart's G. T. Patterson 1-13, Section 13, Block C, L&SV Survey, flowed 360 barrels from Lower Spraberry sand, Permian 7524-77 feet, 39-gravity, 9/32-inch, completed 11-19-51, TD 7577.

Unnamed field. Snowden & Ashland's J. D. Merchant Estate 1, Section 19, Block A, L&SV Survey, pumped 80 barrels from Upper Spraberry sand, Permian 6340-6400 feet, 38.4-gravity, completed 11-3-51, TD 7202.

Runnels County. Aztec Oil Company's Nettie Currie 1, ETRR Survey, flowed 215 barrels from Palo Pinto sand, Pennsylvanian 3424-56 feet, 43-gravity, ¼-inch, completed 11-2-51, TD 4630.

"Morris Whitley" field. Gulf Plains Corporation's N. J. Whitley 1, Section 139, Isaac P. Wallace Survey, flowed 76 barrels from Morris sand, 3484-95 feet, 40-gravity, ¼-inch, completed 11-8-51, TD 3495.

Unnamed field. La Gloria Corporation's C. C. Gray 1, Section 147, ETRR Survey, flowed 83 barrels from Gardner sand, Pennsylvanian 3870-76 feet, 41.4-gravity, 5/32-inch, completed 11-4-51, TD 4045.

Unnamed field. B. C. Morrison's J. T. Brandon 1, Section 18, M. J. Parramore Survey, flowed 1200 barrels from Upper Gardner sand, Pennsylvanian 3830-65 feet, 44.1-gravity, ⅞-inch, completed 10-31-51, TD 3865.

TEXAS DISTRICT 7-C— OIL FIELD EXTENSIONS

Runnels County, Jim Adams field. T. W. Murray's Merry Hunter 1, Section 444, George Berry Survey, ½-mile southeast extension, flowed 374 barrels from Fry sand, Pennsylvanian 4410-32 feet, 43.4-gravity, ¼-inch, completed 11-3-51, TD 4432.

Lloyd field. G. W. Strake's W. F. Chisum 2, Section 94, H. E. Baggs Survey, ½-mile northeast extension, flowed 188 barrels from Fry sand, Pennsylvanian 4313-20 feet, 43.3-gravity, ¼-inch, completed 11-20-51, TD 4330.

Upton County, Pembrook, North field. Ashland Oil & Refining Company's B. Sherrod 1-43, Section 43, Block 37, T-5-S, T&P Survey, 1-mile east extension, pumped 189 barrels from Leon-

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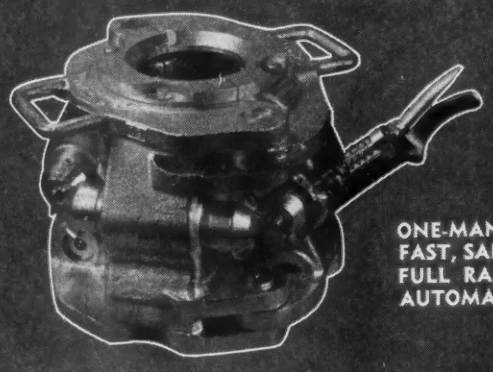

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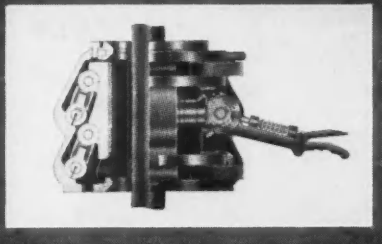
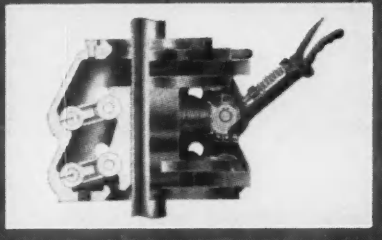


Running in. Slip segments are fully retracted



Slip Set. Note that slip segments are still parallel with the centerline of the pipe. Handle is locked in "closed" position.

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ard sand, Permian 6985-7187 feet, 36.9-gravity, completed 11-2-51, TD 7187.

Weiner Floyd field. Humble's Louise H. Shackelford 2, Section 16, Block 38, T-5-S, T&P Survey, ¾-mile northeast extension, flowed 166 barrels from Spraberry sand, Permian 7140-8187 feet, 38.2-gravity, 21/64-inch, completed 11-21-51, TD 8187.

TEXAS DISTRICT 7-C— NEW GAS FIELD

Sutton County. Shell's W. A. Miers 1 (OWWO), Section 54, Block 14, TW&NG Survey, flowed 22-million from 4247-4333 feet, completed 11-16-51, TD 4377.

TEXAS DISTRICT 8— NEW OIL FIELDS

Andrews County. Humble's University O-1, Section 20, Block 1, University Lands Survey, pumped 18 barrels from Wolfcamp lime, Permian 7082-7104 feet, 32.8-gravity, completed 10-28-51, TD 11,957.

Crane County. Placid Oil Company, Callery & Hurt & Byrd-Frost, Incorporated's A. R. Eppenauer 1 (OWDD), Section 14, Block 6, H&TC Survey, pumped 40 barrels from Devonian lime, Devonian 5161-5318 feet, 39.8-gravity, completed 11-27-51, TD 5395.

Gaines County. E. C. Hitchcock & Son & J. H. Elder's P. S. Dunbar 1, Section 25, Block A-12, PSL Survey, flowed 15 barrels from San Andres lime, Permian 4305-28 feet, 31-gravity, ¼-inch, completed 11-12-51, TD 4328.

Martin County. Ashland's Tant Lindsay 1 (OWDD), Section 17, Block 38, T-1-N, T&P Survey, pumped 12 barrels from Lower Spraberry sand, Permian 8190-8590 feet, 36.9-gravity, completed 11-5-51, TD 8590.

Midland County. The Texas Company's C. Scharbauer NCT 2-B, Section 43, Block 39, T-2-S, T&P Survey, pumped 44 barrels oil and 23 barrels water from Spraberry sand, Permian 7770-8050 feet, 33.6-gravity, completed 11-13-51, TD 8050.

Mitchell County. Stanolind's F. A. Langley 1, Section 25, Block 29, T-1-N, T&P Survey, pumped 16 barrels from Clearfork lime, Permian 4324-4448 feet, 29-gravity, completed 11-22-51, TD 8180.

Ulysses S. Thompson's Fee 1, Block 1, West Colorado City Survey, pumped 4 barrels from Sunflower sand, 41-42 feet, 52-gravity, completed 10-30-51, TD 42.

Ward County, "Leaman Lime" field. Max Leaman et al's E. H. Cary 1, D. K. Taylor Survey, flowed 245 barrels from Leaman lime, 2586-87 feet, 27.9-gravity, completed 11-18-51, TD 2587.

TEXAS DISTRICT 8— NEW OIL PAYS

Glasscock County, Driver field. Sohio Petroleum Company's Mary V. Bryans 1-A, Section 12, Block 37, T-5-S, T&P Survey, flowed 662 barrels from Lower Spraberry sand, Permian 7700-30 feet, 40.5-gravity, ½-inch, completed 11-24-51, TD 8525.

Kent County, Cogdell field. Chapman & McFarlin Producing Company's D. M. Cogdell 33-A, (OWWO), Section 773, Block 97, H&TC Survey, pumped 65 barrels oil and 30 barrels water from San Andres lime, Permian 1475-1570 feet, 36.2-gravity, completed 11-10-51, TD 7683.

TEXAS DISTRICT 8— OIL FIELD EXTENSIONS

Glasscock County, Driver field. Sinclair's J. B. Calverley 1, Section 31, Block 36, T-4-S, T&P Survey, 2-mile east extension, flowed 248 barrels from Spraberry sand, Permian 6767-6910 feet, 36.2-gravity, completed 11-6-51, TD 6910.

Midland County, Tex-Harvey field. Sinclair's John Henderson 1, Section 33, Block 37, T-3-S, T&P Survey, 3-mile southwest extension, flowed 131 barrels from 7072-7174 feet, 38.2-gravity, open, completed 11-23-51, TD 7174.

TEXAS DISTRICT 10— OIL FIELD EXTENSION

Roberts County, Lips field. Sinclair's Charles Lips 7, Section 1, Block 1, BBB&C Survey, 2-mile southeast extension, pumped 10 barrels from 8574-8614 feet, completed 11-17-51, TD 9223.

UTAH—NEW GAS FIELD

Carbon County. Byrd-Frost, Incorporated's Utah Fuel Company 1, NW SW SE 5-14s-7e, flowed 9-million from Ferron sand, Upper Cretaceous 4690-4711 feet, open, TD 4761.

WEST VIRGINIA—NEW GAS FIELD

Preston County. Cumberland & Allegheny Gas Company's Clarence Jones 464-1, Union District, flowed 2.5-million from Chert 4651-4724 feet, TD 4724.

WYOMING—NEW OIL FIELD

Park County. Whistle Creek field. Seaboard Oil Company's Unit 1, NE NW SW 16-56n-98w, flowed 330 barrels from Tensleep sand, Pennsylvanian 5795-5825 feet, 28-gravity, 1-inch, TD 5825.

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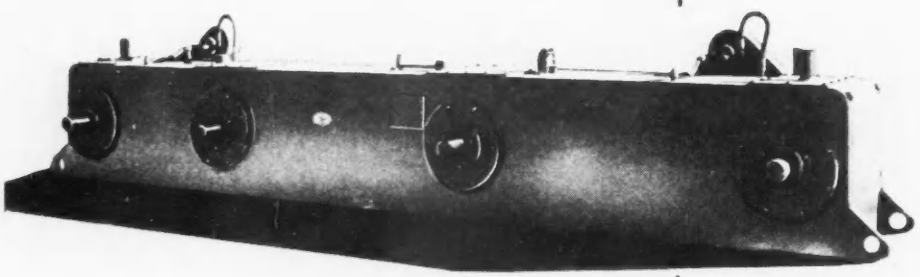

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Power Rig Features Departure from Design Standards

By W. B. COLVIN

WORLD OIL Staff

FIGURE 1. Master panel controlling drawworks, rotary unit, rotary table and circulating mud pump. Flood trouble light is on post beyond console.

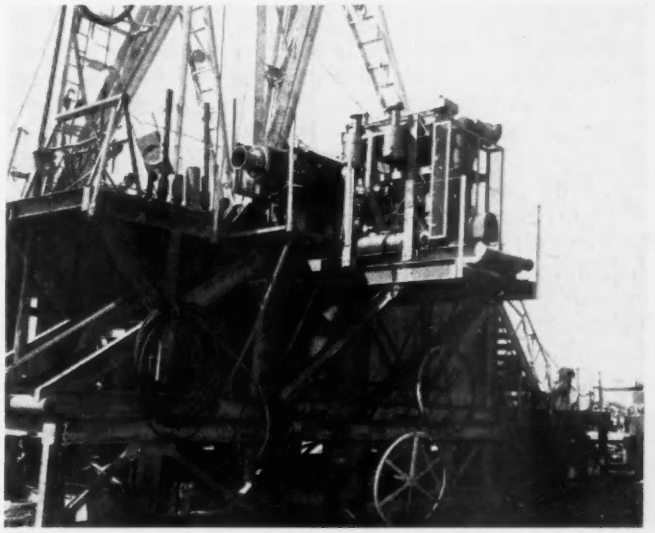

FIGURE 2. View of vertical extension and derrick substructure. Far ends of substructure are sealed for clothes change and tool houses. Rotary unit is supported by side extension to clear derrick floor of heavy equipment.

HERE IS a 900 horsepower torque converter rig with many features not ordinarily incorporated in the design of conventional tools. The remote air-electric drawworks is located under the floor on the truck bed level vertical extension. Operation of the drawworks, and all other capital equipment, is governed by air-electric levers stationed at the movable, master console unit. The steel plate derrick floor is cleared of all equipment except for the rotary, tongs, console and weight indicator box. The rotary unit, resting on a side floor extension, shaft drives the table with a combination torque-hydraulic transmission. Rope catlines are never used since a wire line is snapped into the breakout slot when the rig is not on a trip. The modern, efficient design of this rig is augmented by safe and comfortable working conditions for the crewmen.

A SUBFLOOR drawworks, 900 horsepower torque converter rig with optimum safety and flexibility, is currently on a George and Wrather Oil Company location in Karnes County, Texas. This ultra-modern rig, which represents a radical departure from design standards, was custom built for the Buzzini Drilling Company to expedite moving, rigging-up, drilling and associated operations. The thought foremost in the minds of Arthur and Walter Buzzini was to design a rig capable of swift drilling operations accompanied with many comforts, conveniences and safe working conditions for the crew.

Placing the drawworks at a subfloor level not only speeds the rigging-up process but also decreases the possibility of line and chain injuries to the driller. The air operated catheads are stationed alongside the derrick floor; hence, all cat and spinning lines operate in an area away from members of the drilling crew. Accurate control of each piece of equipment, except for the standby pump, is at the command of the driller seated before an air-electric operated console which may be stationed at any point on the derrick floor.

The movable console (Figure 1) permits finger tip control of the drawworks, core reel, rotary table, rotary unit with catheads and the mud pump powered off the compound. Except for the electric brake on the drawworks, all levers on the console actuate air operated controls. Precision operation of the mechanical drawworks brake is made possible by means of a spring engaging, air disengaging system which automatically jams the bands against the drum in the event the air supply fails. Although the air control system in the console has been well proven, in varied industrial applications, some of the devices were not utilized by the petroleum industry prior to the design of this rig.

The master console houses a series of warning systems which indicate lubricant pressure, temperature and electrical supply to the drawworks brake, torque converters, engine crankcases, compound, rotary and transmission. In some instances, the warning lights are stationed in the immediate vicinity of the equipment in question; however, the operating characteristics of all heavy equipment may be observed at the master console.

Since all of the control units are junctioned to the master console by means of flexible hose extensions, it is possible to move this master cabinet to any desired position on the derrick floor. With this flexibility, the driller

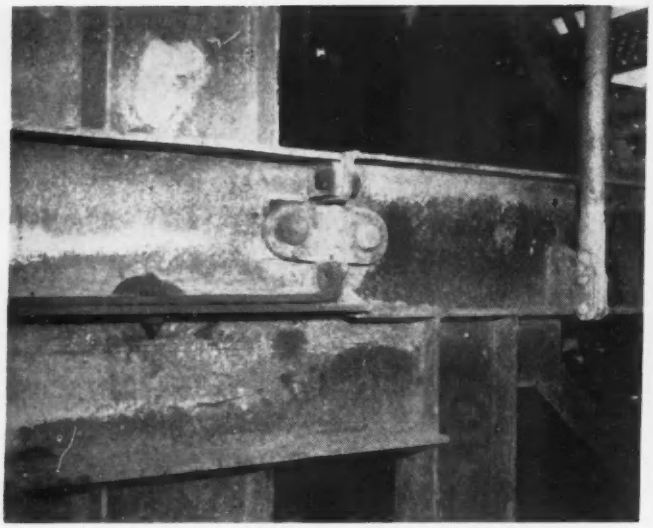

FIGURE 3. Pin and bolt locking mechanism pictured above ties the 52-foot vertical extension in the center. This feature substantially increases portability of the rig extension.

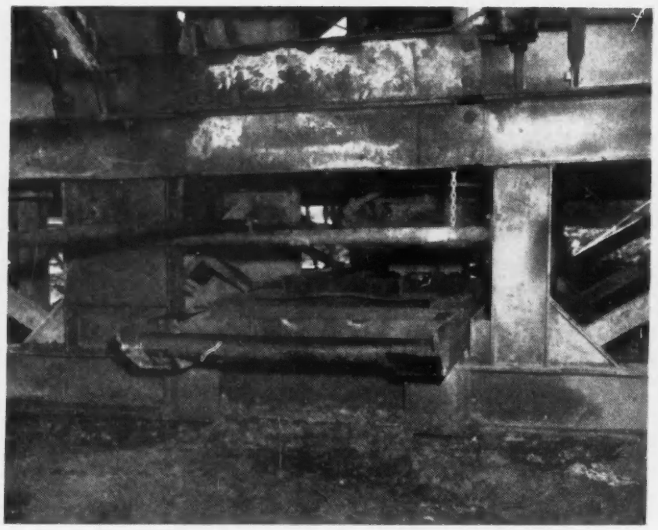

FIGURE 4. Roller rack for handling blowout preventers. Substructure plate members are removable to permit sliding preventers through structure rather than lifting them to the derrick floor.

can station the control unit in the area allowing him the most advantageous view of operations in progress.

The Buzzinis advise that the driller's upholstered swivel chair is more than a mere novelty on their custom-built rig. Conventional equipment requires that the driller be on his feet or in an uncomfortable position during the entire tour unless an automatic drilling device is employed. In the case of the Buzzini rig, the driller may remain in a comfortable, relaxed position at all times, thus warding off fatigue and increasing the driller's efficiency on the job. In case the driller is called on to double over, the assignment is accepted with little or no reluctance because of the comfortable and convenient working facilities.

Substructure Permits Truck Level Loading

A feature of the Buzzini rig is the substructure system (Figure 2) which permits the loading of heavy equipment at a truck bed level. Basic members of the substructure system are the two vertical extensions supporting the rig on the two sides running from the "V" door back to the compound. These box shaped structures are 8 feet wide, 5 feet high and 52 feet long. The base of each vertical extension has a full shoe plate of three-quarter-inch steel, thus eliminating the requirement for matting on location prior to rigging up. Another advantage of the shoe plate is ease of skidding from location to location. Depending upon the terrain, it has been found that the complete rig will skid easily on the sledding surface provided by the heavy steel shoe plates.

The vertical extensions are spotted so that the outer edge is flush with the edge of the derrick substructure. Secure anchorage in this position is assured by the placement of heavy duty dividers between the two extensions. The dividers are installed so that they become flush with the upper plate of the extension.

Transport of the two vertical extensions is simplified by center plate locking devices which permit division of the two structures. In this manner, the two units are reduced from a length of 52 feet to 26 feet.

A nine-foot conventional substructure is clamped atop the vertical extension in the derrick area. With the addition of this segment, the over-all height of the substructure system becomes 14 feet.

The unitized drawworks, transmission, compound and two engines slide over the vertical extension divided system and rest at truck bed height. Attached to one master skid unit, the drawworks, transmission, compound and engines can be maneuvered with comparative ease.

A feature of the substructure system is a blowout preventer rack and slide (Figure 4) adjacent to the wellhead connections. With this provision, handling of the blowout preventers simply involves lifting the units with the drilling line, sliding a heavy duty steel frame under the preventers, dropping the preventers into position and bolting them to the frame. As the rack is equipped with rollers, movement of the preventers through the substructure is a minor problem since angle iron guides permit rapid delivery to a truck stationed at the side of the structure. This plan eliminates the necessity of removing the rotary table and lifting the preventers to floor level.

The remotely controlled drawworks (Figure 5), spooling 1⅛-inch line, is powered by a 900 horsepower transmission rendering the rig capable of operations to below 9000 feet with 4½-inch drill pipe. Completely void of jaw clutches, the drawworks motion is governed by air tube clutches, a structural pattern also found in the chainless, gearless, transmission. Air-torque linkage incorporated in the latter unit lends to steam rig flexibility with an efficient power output.

The torque driven drawworks, nine feet below floor level, feeds the drilling and coring lines through ports (Figure 6) cut in the all steel plate floor. Conventional line guide equipment is installed above the derrick floor and expanded metal guard rails surround each floor port to insure maximum personnel safety.

Elevated Engine Radiators

The two supercharged, 335 horsepower engines (Figure 7) attached to the compound through torque converters, are cooled by elevated radiators. Since the drilling contractor is often faced with the problem of power plants overheating because of the lack of adequate circulation, the Buzzini rig is equipped with conventional radiator cores attached above each engine. Operation of the radiator fans is made possible by belt drives from the regular engine pulley to a shaft immediately above the head of the engine. Another pulley on the elevated shaft transmits force through a bevel gear box to the radiator fan. With blower type fans in service, cool air is pulled up alongside the engine and discharged through the elevated core. Field use of the installation has shown the following advantages:

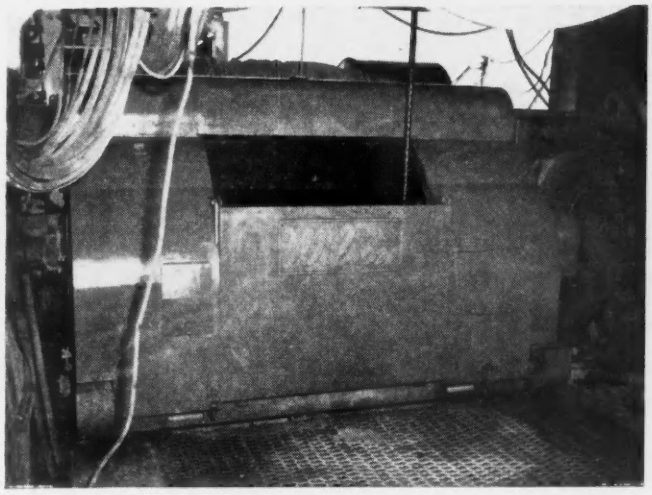

FIGURE 5. Subfloor, air-electric controlled drawworks and coring reel. Capable of drilling below 9000 feet with 4½-inch drill pipe, the drawworks is mounted at truck bed level to facilitate ease of handling.

FIGURE 6. Floor ports for drill and core line are surrounded with guard rails. Rotary table rests in two-foot well, while master control box and indicator rack can be positioned as desired on steel floor.

- The engine radiators need not be faced into prevailing winds during extremely hot weather.
- The problem of the engines overheating is reduced to a very minimum.
- The engine block remains full of fluid at all times, thus reducing the hazard of pouring cold water into an empty cooling system.
- The engine mechanic has convenient access to all four sides of the engine since the radiators are in an elevated, out-of-the-way position.
- Engine width is reduced approximately two feet.

Cooling medium within the radiators is maintained at the desired level at all times with float type, automatic filling devices. Incidentally, the same type mechanism is employed on the crankcase of each engine to carry the desired amount of lubricant in the unit continuously. Water for the engine cooling systems is processed by a combination filter, softener and rust inhibitor permanently attached to the vertical extension unit nearest the engines. The current unavailability of radiator cores prompted the owners to provide every possible device contributing to the extended and efficient service of the engine cooling system.

A smaller core is installed immediately above the engine radiator to assist in the cooling of torque converter fluids. Given the advantage of forced ventilation, no difficulty is experienced in the process of keeping the torque units at the desired temperature level.

Each engine on location is rigged with weather caps on the exhaust pipes to prevent the entrance of rain or foreign objects while the equipment is not in operation. Hinged, flapper type devices, the covers remain open due to exhaust pressure while the engines are in operation. The minute the engines are shut down, the flappers immediately drop over the vertical exhaust pipes to form comparatively tight doors.

The two dual fuel, supercharged engines on the compound, and a comparable engine on the rotary unit, are all equipped in a like manner.

Compound Drives 20-Inch Pump

The full torque converter compound drives one 7¾ x 20 master pump normally used while drilling. The versitility of the torque drive is well demonstrated by the fact that liners of the same size can be employed during an entire operation. In turn, shock loads are readily absorbed by the torque units.

Since the outboard drive on the compound is just five feet above ground, the need for long V-belts is virtually eliminated. Proximity of the pump to the drive pulley permits use of short belts which may be easily adjusted to insure long service life.

The mud pump system is supplemented by a 7¼ x 18 mud mixing or utility pump driven by a 375-horsepower, slow speed engine. Manifolded with the master unit, the standby pump can be relied upon in the event of an emergency or if the large circulating pump requires repair work. Although smaller than the master pump, the standby unit is used to a very definite advantage in the process of mixing mud, gunning the pits or other utility purposes.

The two mud pumps are the only heavy units on location which are placed on timber matting. As a matter of fact, the pump matting is the sole lumber requirement on location.

The 27½-inch oil bath rotary table is shaft driven by a 335-horsepower torque converter-hydraulic transmission better known as the rotary unit. Contrary to conventional rig-up practice, the rotary table and rotary unit are the only heavy equipment that must be lifted to floor level. Rapid and proper alignment of the rotary is assured by a rotary well countersunk two feet in the metal plate floor. Precision alignment of the table is possible by means of metal spacer lugs dropped into the oversize well.

The rotary unit (Figure 8) is stationed to the left of the driller's position for the completion of normal drilling operations. To eliminate all equipment on the ⅜-inch steel plate floor except the control console, countersunk rotary and tongs, the rotary unit is anchored to a support unit at the side of the derrick floor.

The transmission in the rotary unit is an adaptation of the type employed in ore trucks and military tanks. With three speeds forward and one reverse, the transmission responds to the demands of the driller at the master console even with the machinery in motion. This completely oil bathed, hydraulic-torque transmission system is operated with an air control system.

Power from the combination torque converter-hydraulic drive unit is shaft transmitted through two universal joints to the rotary table. Power supplied by this multifeature drive system is buffered in the event the rotating speed of the pipe lags due to a change in drilling or hole conditions. The presence of this characteristic aids in eliminating, or at least reducing, the ever present possibility of twist-offs and expensive fishing jobs.

Air operated, 18-inch catheads are attached to each side of the rotary

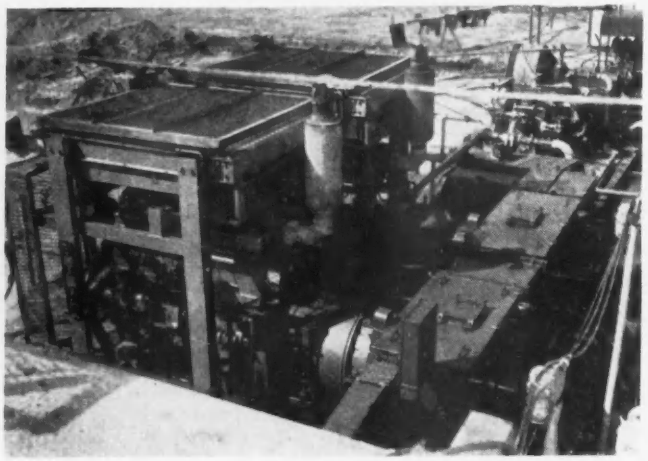

FIGURE 7. The radiators rest on top of the engines to increase their cooling efficiency and permit easy access to equipment for repairs. Each prime mover is connected to compound through torque converters.

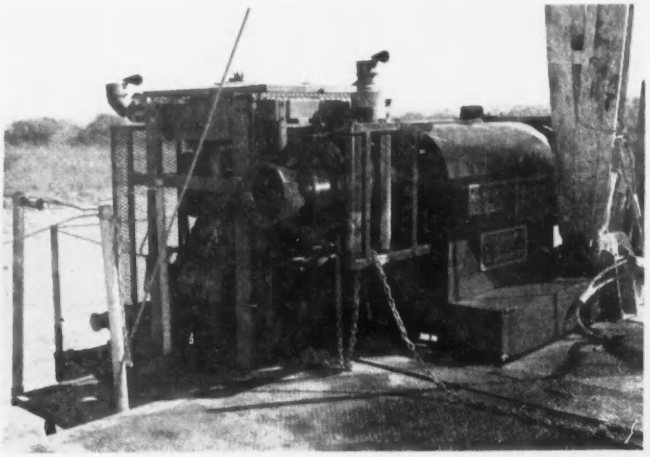

FIGURE 8. Rotary unit supplying shaft driven power to rotary table has air operated catheads. Replacing spinning chain or tong line with steel catline eliminates need of wrapping rope on cathead.

unit. While tripping the pipe, the catheads are controlled from the master console for operating the tongs and spinning chain. However, during the process of normal drilling operations, the break-out line is removed from the cathead and substituted by a snap attaching wire catline. Operation of the cathead spooling the derrick line is controlled by means of an air clutch and friction brake located immediately behind the cat shaft. In this manner, it is not necessary for a crewman to be within close proximity of the operating cathead. Rope catlines are never used.

Dual Compressor-Generator Unit

Compressed air and electricity is furnished the rig by two, 30-horsepower gas or butane fueled engines driving two 10 kilowatt generators and two 40 cubic feet compressors. Air delivered by the compressors is stored in a 16 cubic feet, 150 pounds per square inch volume chamber attached to the unit skid. Assembled in a manner to allow operation of one engine, one generator and one compressor as an independent unit, the device is used as a dual system operating one set of equipment each tour with the other components down for servicing or repairs. Although a simple procedure, records show that by alternating demands on each unit for an eight-hour period, all equipment has extended service life and is properly maintained at all times.

Vapor-Waterproof Lighting System

The lighting system is fully vapor-water proof with all flood lights permanently installed in the derrick and substructure. Lines are anchored in place and all junctions are equipped with union type connections. Design of the system does not require removal of the flood lights or lines in preparing the rig for a move.

To complete facilities on their rigs, the Buzzinis designed and installed electrically actuated drilling time recorders which respond to signals transmitted from the drawworks drum shaft. Since no mechanical wire leads are involved, placement of the recorder presents virtually no problem. On each rig, the recorder is installed in the toolpushers bunk house with a light immediately above the chart.

Heat sensitive charts are employed on the recorder instrument to eliminate the need for an inked stylus. The stylus is equipped with a heat radiating tip which transfers an informative drilling rate curve to the clock rotated chart.

Rig-Up Time, Trucking Requirements Reduced

Although the Buzzini rig was designed with the intent for more efficient operating conditions, crew conveniences and safety, the net result of this unitized equipment was a reduction of one day in rig-up time and three trucks in transport. The efficient manner in which the machinery is organized permits completion of the rigging-up process prior to spudding in; hence, the waiting-on-cement period after the conductor and surface pipe have been landed is devoted to maintenance and repair projects around the rig.

Even though the rig has been streamlined to a point wherein trucking requirements have been reduced, there has been no sacrifice of equipment on location. The Buzzini rig is complete even to the toolpusher's bunkhouse and mud storage house. Clothes change and tool house is within the derrick substructure, thus eliminating the need for independent units.

The Buzzini rig reported in this article is a twin to a unit built by the company over two years ago. Under the circumstances, the unit, in its entirety, has been subjected to thorough and rugged field trials. To date, no difficulty has been experienced with the subfloor drawworks arrangement, transmission, compound or the rotary drive and cathead unit. Although the equipment represents a rather drastic trend away from conventional designing, the rig has demonstrated outstanding performance. From all records, this is one of the only three subfloor drawworks rigs in the industry. A twin unit to the rig described is owned by the Buzzini Drilling Company while the third unit is operating on the West Coast.*

Placement of the drawworks at a subfloor level has eliminated the necessity for lifting heavy equipment above the base substructure. Unitization of the drawworks, transmission, compound and engines has reduced the time requirement for spotting equipment on location. At the same time, the outboard pump drive lends to a reduction of belting problems.

Although the rotary unit represents an extra load, the valuable utility of the equipment plus the load it relieves from the drawworks, well illustrates its importance.

It has been previously mentioned that the foremost thought in the minds of the Buzzinis was to provide a rig with the optimum in safety, convenience and comfort for the crewmen. Of course, this factor in itself has paid unestimable dividends by the route of excellerated crew loyalty, increased initiative and the ever evident attitude—"Let's give 'em a good day."

* A comprehensive report of the latter rig is included in Gilbert M. Wilson's article, "Diesel Electric Rig Designed for Medium or Deep Drilling." WORLD OIL, page 111, May, 1951.

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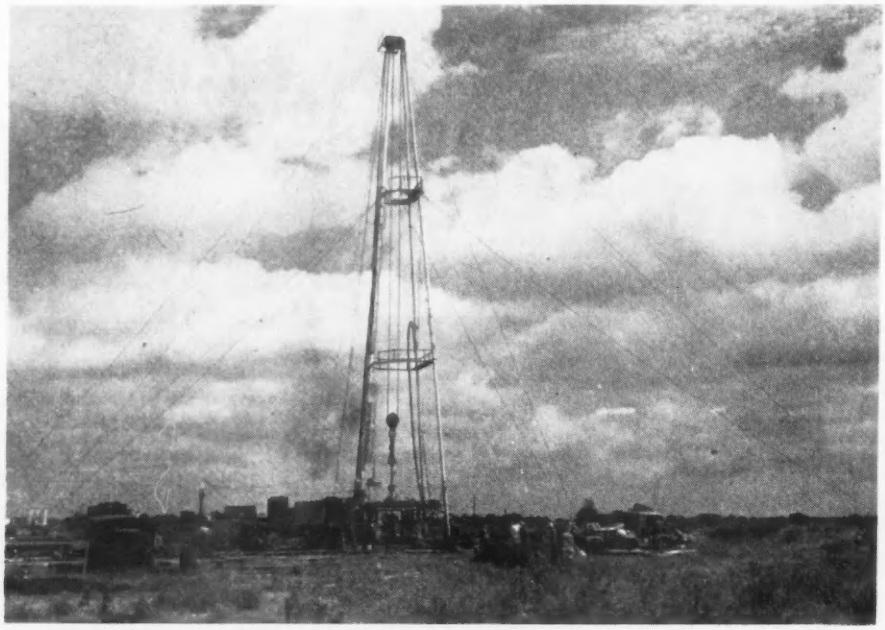

FIGURE 1. General view of the tripod-type mast. The main mast member, which is attached to the trailer bed, telescopes into position hydraulically.

Field Use Proves Tripod Rig

By H. W. SLATER, Slater Well Service Company

EXTENSIVE well service, deepening and actual drilling operations during the past five years have proved the versatility of a tripod rig designed with attention to economics, rapid well-to-well moves and the efficient, speedy completion of varied assignments. Introduced after three years of intensive research, drawing board planning and modeling, the workover tools operated by the Slater company represent a landmark in medium size rig design. With 275 torque converted, supercharged horsepower operating the air controlled drawworks, this type rig is capable of maneuvering a 150,000-pound load with comparative ease. The obvious utility of these workover rigs has prompted the owner to increase the number of units from one in 1945 to two since 1946.

Prior to the development of the tripod type rig, the market offered medium size rigs weighing 200,000 pounds or lightweight pulling units within the 30,000-pound category. In view of the class tools available, I felt a definite need for a rig of the intermediate design; a portable, light weight rig tall enough to handle doubles and sturdy enough to do most jobs in the field.

Experimental development of the tripod rig consumed a three-year period of engineering layout, stress analysis, modeling and abbreviated alteration of available equipment. Then, in 1945, the first tripod rig was constructed in a Victoria, Texas, machine shop. Fortunately, the initial engineering design work of the tools proved to be complete and exact, as little or no difficulty followed the ultimate on-location assignments for the tools.

Aside from minor equipment alter-

RAPID RIGUP and flexible drilling or workover operations are possible with the shop-made, truck-mounted, three-legged mast rig. The first rig was designed and built by the author in 1945 to fullfill a need for medium-size workover tools featuring portability, a roomy mast with unobstructed visibility, and horsepower necessary to maneuver tools in deep Gulf Coast wells. Aside from the air-controlled, torque converter drawworks and auxiliary spool, an outstanding feature of the rig is the three-legged, self-aligning mast. Compact dimensions of the rig permit ease in transportation and eliminate the problem of travel through low underpasses or narrow bridges.

ations, the only radical change made in the rigs during the past five years includes the installation of a conventional standpipe. Before this change, one of the supporting legs of the mast was used for this purpose. However, concern over possible pressure damage to the supporting member prompted the minor change in design.

Portability Featured

With one crew on location and no additional trucks, the rig can be assembled and operations resumed within 8 to 12 hours. The rig-up operation merely involves spotting the truck and trailer, telescoping the main mast leg and engaging the two helper legs by means of lock sleeves attached to the special crown assembly atop the mast. Proper reinforcement of the tripod is assured by means of the pipe rack and an adjustable telescoping brace stationed halfway between the pipe rack and the ground. The operation of elevating the mast is accomplished by means of a heavy duty drum immediately behind the drawworks. Serving as a powerful, safe cathead, this auxiliary drawworks assists in the process of stripping the Christmas tree, landing the rotary, spotting the substructure and associated operations.

Following the assembling of the mast, the remaining operations consist of locating the substructure, aligning the rotary table, laying mud, water and fuel lines to the rig and inaugurating either remedial or actual drilling operations. Since the lines and blocks remain strung when the mast is dismantled, it is unnecessary to string-up when the mast is reassembled.

A feature of the supporting legs is a screw adjustment, resting on the matting, which permits proper balancing of the mast and elevation to a point which will permit installation of a substructure of the desired height.

Guying the mast is essential only during the process of erection. Drilling or general rig operations find the eight guy lines, four attached to the pipe rack and four connected to the crown, in a nonstressed condition. Engineered design of the mast compensates for settling and the ultimate relay of strain to guying members.

Dismantling the rig is accomplished in the same speedy manner accompanying the rig-up procedure. The loaded rig, ready for transport, has an over-all length of 52 feet including the ten-ton tandem diesel truck and trailer which represent a gross load of 70,000 pounds. The collapsed unit is

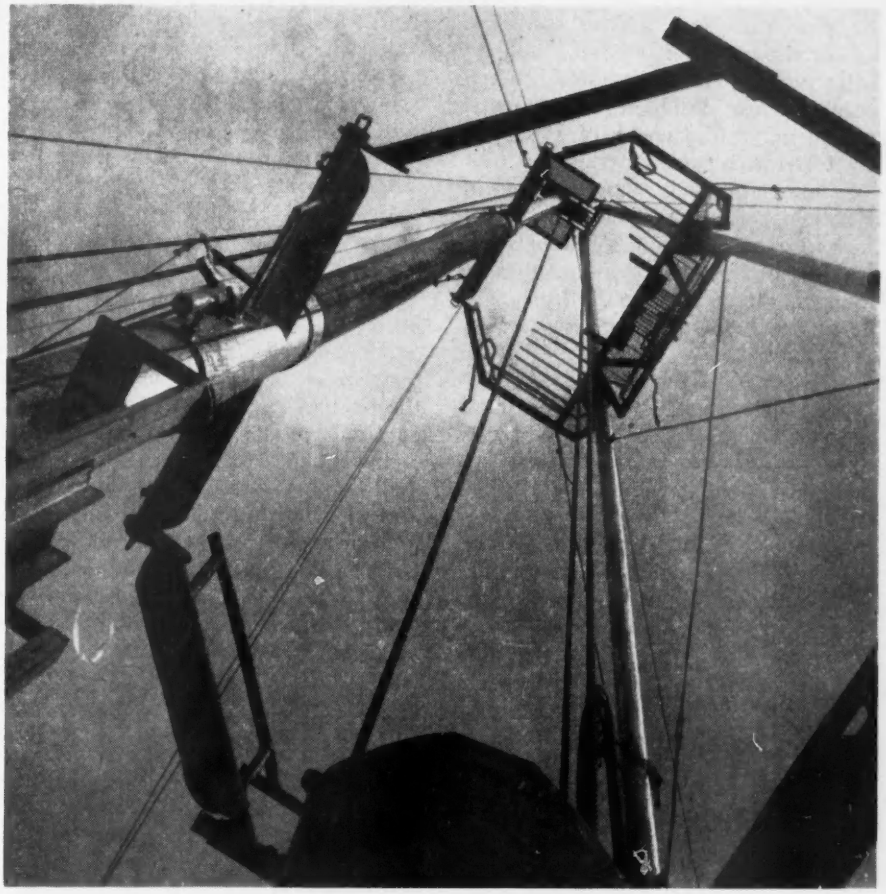

FIGURE 2. View of the double board and cross bracing which assure perfect alignment of the tripod mast at all times.

36 feet long; 8 feet, 8 inches wide and 12 feet, 4 inches high. With these dimensions, no difficulty is experienced in moving the rig through low underpasses or narrow bridges.

The unitized mud pump with its prime mover, the pipe rack, derrick braces, and two auxiliary legs are moved separately. The substructure, when inverted, serves as a rack for timber and like equipment.

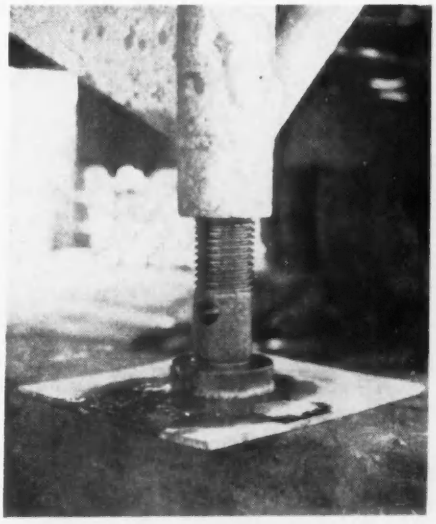

FIGURE 3. Each helper leg is equipped with a screw adjusting unit to permit the desired leveling of the mast when assembled on location.

Aside from the mast design, another unique feature of this workover or drilling unit is the fact that the substructure can be adjusted to nearly any level. In this manner, the height of the Christmas tree is an unimportant factor when readying the rig on location. Often a problem when standard height substructures are employed, the adjustable feature of this structure unit permits rapid assemblage over trees of varying heights.

Mast Design Detail

The master mast segment is fabricated from 13⅜-, 11¾- and 9⅝-inch heavy duty seamless casing. Attached to the bed of the eight-wheel trailer, and made as a part of the drawworks, the main mast leg telescopes because of the staggered casing sizes involved, with the aid of the powerful auxiliary drum behind the drawworks. This 94-foot derrick will telescope down to approximately 36 feet for transport. The helper legs are lifted into position by means of the traveling blocks suspended from the crown. Frames for the bracing members, consisting of

the pipe rack and master spreader, are constructed of three and four-inch drill pipe segments. The bracing members are designed to telescope from a maximum width of 10½ feet to 8 feet for convenient transport.

Supplementary bracing consists of one-inch rods forming a cross below the pipe rack and a "V" door from the base of the legs to the adjustable brace located at one-half the height of the double board.

Weight Distribution

The design of this tripod mast allows for spotting the crown directly over the well head connections. The horizontal distance from the base of the master leg to the center of the crown block is approximately six feet, while each helper leg is stationed 12 feet from the central area of the block. Since the master leg stands in a near vertical position and since both the dead and fast line feed off the crown on the same side, the weight distribution on the mast unit assigns approximately 60 percent of the load to the master leg and 20 percent of the remaining load to each of the two supporting legs.

Vision up the mast from the drawworks position is virtually unobstructed and, with the added height, it is possible to swing test tools connected to a double stand within the derrick area. Pipe racking presents no problem as the derrick design permits the secure racking of 9500 feet of 2⅞-inch tubing, 12,000 feet of 2⅜-inch tubing or 6000 feet of 3½-inch drill pipe. Access to the double board and crown is provided by means of a permanently attached, telescoping ladder. The position of the dead line is such that the weight indicator is stationed close to the driller's station at the drawworks.

The air controlled, torque converter drawworks, the auxiliary drum and the 275-horsepower supercharged engine are mounted atop the eight-wheel tandem trailer. The unique equipment design permits rapid rig-up of the tools since all of the trailer mounted equipment remains in an operating position at all times.

The unitized 7¼x12 diesel driven mud pump is so designed that installation of a mud line from the unit to the rig is the only requirement. The suction hose, attached to a pivot system, swings over the skid frame for transport from location to location. Adjustment of the suction level is possible by operation of a winch attached to the pivot stand. A unique feature of the system is incorporation of the mud discharge line in the skid unit crossbeam. This plan reduces the outside piping requirements of the unit and makes for a neater over-all appearance.

The only heavy equipment which must be moved into position on location is the 17¼-inch oil bath rotary table. However, with the substructure design and the assistance of the auxiliary trouble line, even this operation may be carried out in record time.

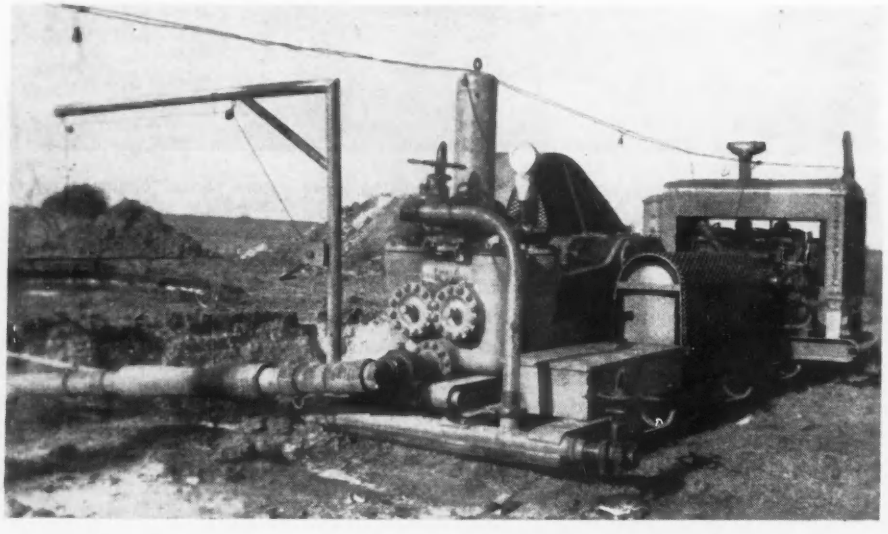

FIGURE 4. The unitized mud pump unit features a pivoting suction hose support, a hose rack and incorporation of the mud line in the skid spreader element.

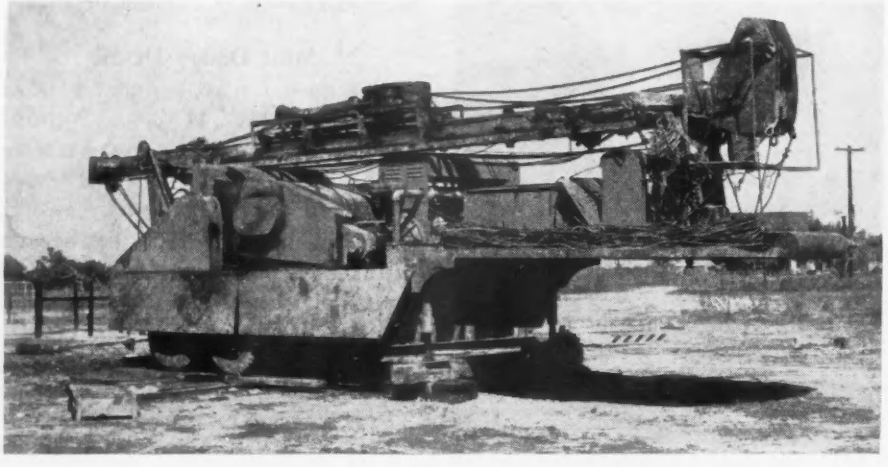

FIGURE 5. The unit trailer ready for transport has dimensions within limits of highway restrictions. Since all lines are left in position, it is not necessary to string up on location to location moves.

Field Performance

Aside from a definite adaptability to workover operations, the tripod rig has been employed in drilling operations to depths below 4800 feet using 3½-inch drill pipe. Deepening programs have been completed from 4700 to 5600 feet, following the removal of a production screen, with 3½-inch drill pipe. The heaviest job the rig has been placed on involved the pulling and rerunning of 10,400 feet of 3½-inch upset tubing.

The sturdiness of this engineered tripod derrick was well demonstrated when 1400 feet of 2⅞-inch tubing was blown out on a workover operation. Although the tubing was blown through the derrick, the only damage occurring was the removal of one rung from the ladder and two fingers from the pipe rack.

Future Plans

In view of the successful operation of this rig, future plans include a completely hydraulic mast unit. Currently, the main mast pole is positioned with an auxiliary line inside the mast; however, when the two helper legs are converted to hydraulic units, the process of erecting the mast will be completely hydraulic.

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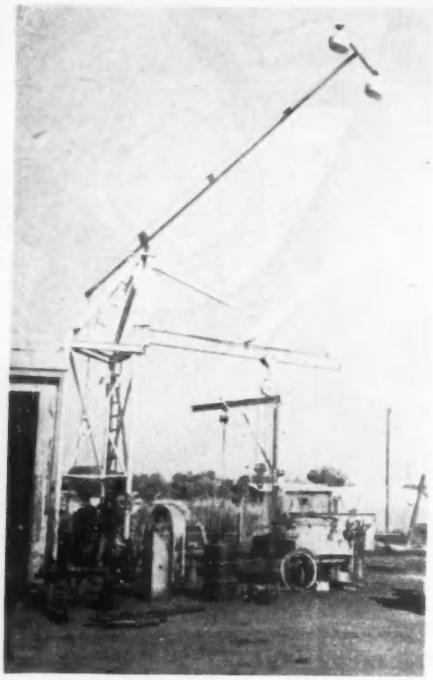

When drilling tools are to be repaired on 24-hour works program, adequate illumination is assured with boom-supported flood lights that can be raised or lowered with winch line at the short end of the boom.

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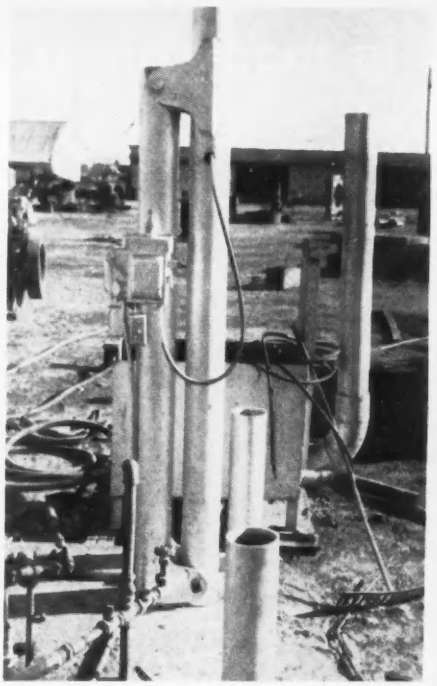

This is the ground end of the flood light mast, showing hinge, light switch, and heel locking pin. This part is to permit lowering mast to replace bulbs without the necessity for climbing ladders.

THE lighting problem of a drilling rig maintenance yard has been solved to the satisfaction of Loffland Drilling Company at Bakersfield by the installation of controlled flood lamps. These permit the evening and morning shifts to repair equipment as efficiently as the daylight group.

Since the major parts of a drilling rig are too bulky to be set inside the repair shop itself, reconditioning of big engines, drawworks and rotary tables must be done outdoors on suitable days. It was decided that appropriately designed and strategically located flood lamps would provide effective illumination over the area where outdoor work was being done at night.

Two locations were chosen for the lights, one at the corner of the repair shop where a davit-type crane was mounted on a special derrick to enable it to be moved through an arc of approximately 225 degrees. The top of this derrick is finished with a flat crown to mount a swivel connection supporting a boom carrying the movable floodlights at this point in the yard. The boom for the lamps is a joint of extra heavy two-inch pipe with a truss rod attached so it will lay above the boom and is separated from the pipe with spacing braces. The arms at the lamp end are a similar piece of pipe fitted with regulation fixtures to attach hooded flood lamp reflectors. Wiring is carried through the pipe in the same manner as through conventional conduit. The short end of the boom has a wire line attached that descends to a hand-operated winch so the boom may be raised or lowered through any adjustment desired. For general illumination, the boom is set at a high angle, but when concentrated lighting is necessary over a reasonably small area, the boom can be lowered so the floor lights will direct the beams upon the piece of equipment being repaired. This type of boom is especially desirable when globes burn out, as the boom can be lowered down to the ground so changes can be made without using a truck boom, a ladder, or attaching climbing rungs to an ordinary lamp post. As the crane can be moved through a long arc, the lamp boom can be adjusted to follow so loading or unloading parts and equipment at night can be expedited.

A different type lamp standard is designed for the general area of the rig yard with flood lamps adjusted to cover a wide area. It, too, may be lowered to the ground, but requires a truck boom for handling. The post to which the standard is attached is a length of four-inch discarded drill pipe set into a concrete foundation. This operates as a light switch panel as well as a support for the lamp standard. Two similar hinges are attached to the top of the post and to the base of the standard. The top hinge is fitted with a permanent hinge pin and the sides of the hinge are long enough so the lamp standard will clear the top of the post when the standard is lowered to the ground. The bottom hinge's flat sides are welded to the bottom of the standard with the locking ferrule attached to the base of the post where the hinge pin is passed through and secured with a nut or cotter pin.

The armored cable for the lights passes through a grommet in the side of the lamp standard and carries two circuits, one for the large floodlights, and the other for low power night lights which are used when no work is being done in the shop. The cross arm at the top of the standard is similar in construction to the arms on the shop corner boom, and carry similar fittings for reflectors. This design is especially beneficial to the shop electrician, as he can lower the standard to the ground to replace burned out bulbs instead of climbing a slender pipe.

Hole Straightening Methods

By GORDON JACKSON

Vice President, Eastman Oil Well Survey Company

THE TREND toward increased drilling rates has resulted in the benefit of more rapid well completions plus the ever prevailing and increased possibility of crooked holes. Through the years, new corrective measures have been devised, the more recent of which are reviewed by the author.

STRAIGHTENING crooked well bores which have exceeded maximum deviations during drilling operations is a major problem in the oil industry. In spite of all precautions during drilling, wells many times become deflected to a degree that makes it necessary to have the direction of the well bore turned back under the surface locations, or straightened to vertical. In many "crooked hole" areas, the need for straightening operations has increased because of deeper drilling now in progress, and by the maximum bit weights needed to obtain economical penetration rates in hard formations.

The drilling contractors and the drilling departments of many oil companies have undertaken experimental programs in an effort to develop practices which will keep a bore hole near vertical, and still permit reasonable drilling rates in hard formations. These new theories have been put into practice, and in many cases have proven beneficial; however, while they have helped, they have not completely eliminated crooked holes and straightening problems. In many areas the formation characteristics are such that in spite of all precautions, such as stabilization of the drill string, or the use of oversized drill collars, light bit weights have to be maintained at the expense of slower penetration or the well will drift from vertical.

Crooked Wells

There are many concepts of what constitutes a straight or crooked well, and also the reasonable limits of straightness or maximum deviation from vertical which can be permitted and still maintain the desired mechanical factors necessary in successfully drilling and completing wells. At the present time there is a definite trend toward a concept wherein the course or direction of the well is considered a major factor, as well as the vertical drift angle, in judging the mechanical condition of the well.

The factor of direction as well as drift angle should be considered when trying to define when a well is straight or crooked. It is entirely possible for a well to be straight and still have a considerable angle, while another well with a very low drift angle could be very crooked because of directional changes in the course of the well bore.

Directional drilling operations have substantially proven that the actual angle from vertical is not nearly as significant as the rate of change, per unit-distance drilled, of the direction and drift angle in the course of the well. In directional drilling, limits are set up specifying a maximum change of course, or "dogleg," sometimes referred to as curvature, which cannot be exceeded in any 100 feet of hole. In straightening, this factor must be considered if mechanical trouble such as keyseats are to be avoided. In other words, the straightening should be at a uniform rate within safe limits.

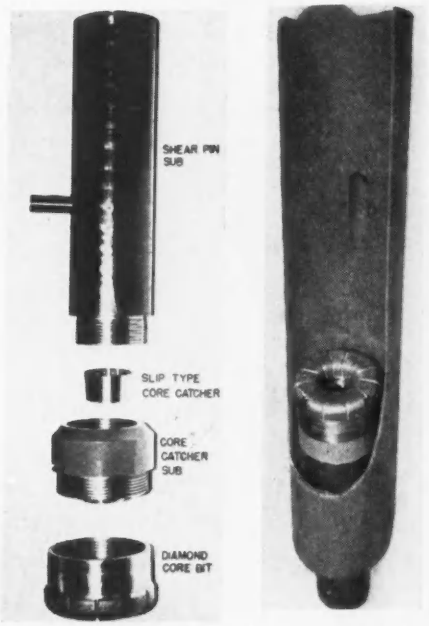

FIGURE 1. Left, the component parts of the diamond core bit drilling setup for use with removable whipstock. View at right shows the diamond core head in place in the removable whipstock.

Straightening Problems

In spite of all drilling precautions, the well bore may deviate radically in its drift or direction between two drift angle readings or directional surveys. Well bores will many times change angle or direction very rapidly and the tendency to go further off course is magnified once the curvature in the well bore is allowed to start.

The first type of straightening operation is undertaken when the well is not allowed to drift beyond certain prescribed limits before straightening operations are begun. The conditions and proper timing will depend on many factors, such as formation characteristics, the economic drilling rate, and the hole size. In most cases the maximum allowable angle above which the hole shall be straightened will be less than the maximum drift angle limit allowed in the drilling contract.

Generally there is a critical drift angle above which heavy bit weights cannot be carried without danger of a well bore changing course rapidly. As the well approaches this critical angle the operator has two choices: he can reduce the drilling weight and allow the plumb-bob effect of the drilling string to bring the well back to within safe limits before heavier weights are again applied, or he can set deflection tools to reduce the drift immediately and thus be able to drill ahead with the best possible weight necessary for fast penetration.

The whipstocking or deflecting tools will be set in a manner to lower the drift angle and at the same time start a tendency for the well to straighten up in a spiral path. As soon as the deflection tool run is completed, normal drilling operations can be resumed and continued until the critical angle is reached again. The decision of whether to attempt straightening by reducing bit weight or to force the well bore back to vertical by the use of removable whip-

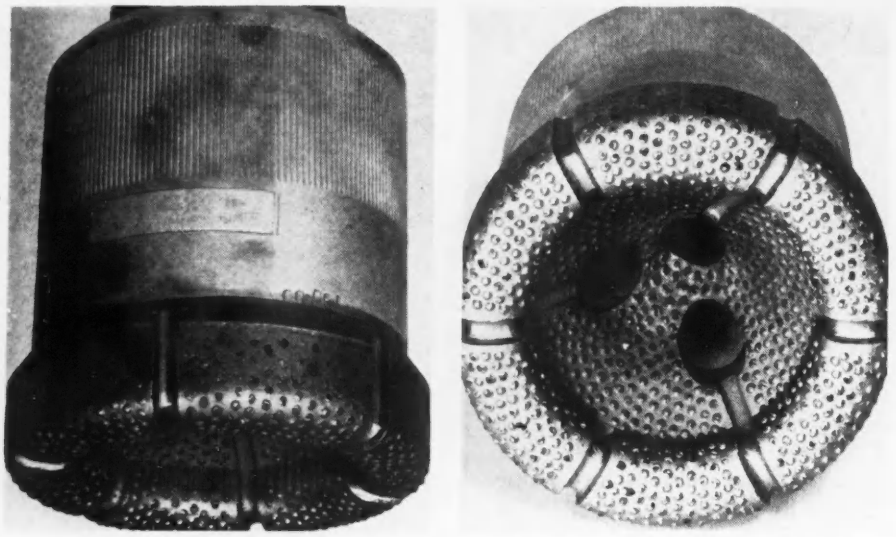

FIGURE 2. A new type diamond bit used on the removable whipstock. This bit does not cut a core and is run directly on the drill pipe.

stocks is mainly a consideration of the time factor. In many instances, the proper employment of directional drilling methods saves time as it allows the operator to quickly resume normal drilling rates and bit weight.

The second type of straightening operation is required when a well is allowed to exceed the critical drift angle, above which the drift will increase rapidly within a very short distance. Normally, under conditions such as these, the drift angle at the bottom of the well will be too high to permit straightening operations with deflection tools at that point. If the curvature or increase in the drift angle is very sudden and has taken place within a very short distance, it sometimes is possible to back up the hole to a point where the drift angle is low, and by reaming carefully, a shoulder can be started and the crooked portion of the well straightened. This type of operation is slow and time-consuming, especially when attempted in hard formations. The only other reasonable alternative is to plug back to a point where the angle is well within the prescribed limitations, and by using deflection tools, sidetrack the plug toward the low side of the well.

Straightening operations from a plugged-back position naturally result in the added cost of time needed for plugging, mud conditioning, and the re-drilling of the portion of the well which has been sidetracked. This added expense can be held to a minimum if drift angle shots are taken at more frequent intervals while drilling through difficult zones. If it appears that the drift angle has a tendency to increase, the well should be straightened immediately at this point, and not be allowed to drift to a point where a plug-back job is required.

Straightening Tools and Methods

The majority of straightening operations where deflection tools are necessary to bring the well bore back within the prescribed limits occur at depths where hard formations or steeply dipping beds are deflecting the course of the drilling bit. Under these conditions, it is necessary to re-design the normal deflection tools and adapt special hard formation diamond bits and reamers to directional drilling practices. It is now possible to successfully accomplish directional work, straightening operations, or the sidetracking of cement plugs in formations which can only be drilled with diamond bits. The most frequently used deflection tool for this type of work is the removable whipstock.

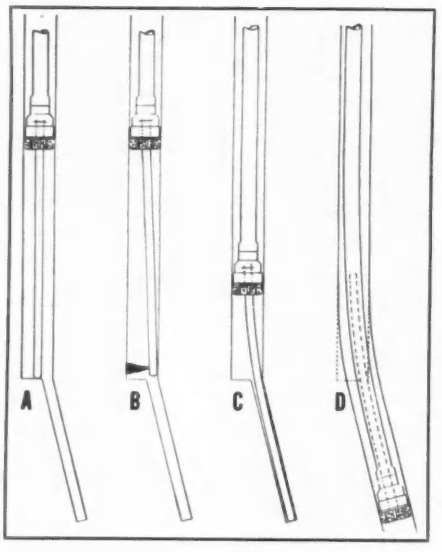

FIGURE 3. Special diamond bit for reaming pilot to full gauge: A, Reaming assembly on bottom; B, locating rat hole with jet action; C, pilot in rat hole; D, pilot entering drill pipe.

Three main types of diamond bit drilling programs have been adapted to use with the removable whipstock. In certain types of sidetracking used in conjunction with hole straightening, the diamond core barrel is employed with a standard diamond bit. Under other conditions the core bit is run on the drill pipe with a special core catcher sub, and the core is allowed to extend upward inside the drill pipe. When the core-head type of bit is used on the whipstock, the core retrieved after the run gives the operator visual proof of a successful sidetracking or straightening job. These types of equipment are shown in Figure 1.

Figure 2 shows the type of diamond bit which does not cut a core when drilling-off a whipstock. This bit will not drill quite as rapidly as the core type bit, but has a number of advantages which offset the slower penetration rate. It can be used on regular drill pipe and eliminates the use of a core barrel. It is also the only type bit which can be used where the drill pipe size, or the size of the hole, does not allow enough room for the cutting of a core. All three of these diamond bits are being run successfully in straightening operations, and most standard deflecting tools can be equipped with diamond heads.

When a removable whipstock with a diamond head is used in hard formation, the pilot hole made by the whipstock bit must be reamed to the same size as the full gauge hole. In addition to the reaming operation, the dogleg or bend imparted to the hole by the whipstock bit must be smoothed out to prevent keyseating at this point by the drill pipe. In medium hard formations, this reaming operation is accomplished with a conventional rock-type reamer. In many cases, however, the formation is too hard, and special types of diamond reamers must be used. If this practice is followed, it is often difficult to force the pilot of the reamer in the small pilot hole left by the whipstock bit. When the hole diameters are small, the drill pipe will naturally tend to align the reamer pilot with the bore of the original hole and prevent the entrance of the pilot into the angular whipstock hole.

Two types of diamond reamers have been developed to allow the pilot to enter the rat hole both in sidetracking plugs and in reaming hard formations. Figure 3 illustrates a reaming procedure including a diamond washover shoe where in the pilot is jetted to the side of the well and then lowers into the pilot hole. Next the core bit or washover shoe

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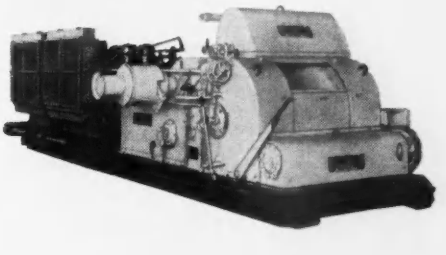

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is rotated down over the pilot to the bottom of the hole. As the diamond core bit cuts downward, it follows the curve of the pilot and reams the whipstock hole to full gauge. This method of reaming results in a smooth curve, which prevents future keyseating problems. The device has the advantage of reaming completely to the bottom of the pilot hole; and by having a nonrotating guide over which the core bit drills smoothly, damage to a cement plug or the consequent loss of the sidetrack run is prevented.

Figures 4 and 5 show the newest development in diamond pilot reamers. The pilot on this reamer is fixed to the body with a ball and socket joint so that it can swing freely. The hydraulic jetting action at the base forces the pilot to swing toward the side of the bore where it will easily enter the pilot hole. This tool circulates through the pilot while reaming and can be made rugged even for small diameter well bores. The pilot will start the reaming action of the diamond shoe above the pilot hole shoulder and will, because of its flexibility, align itself with the angle of the pilot hole.

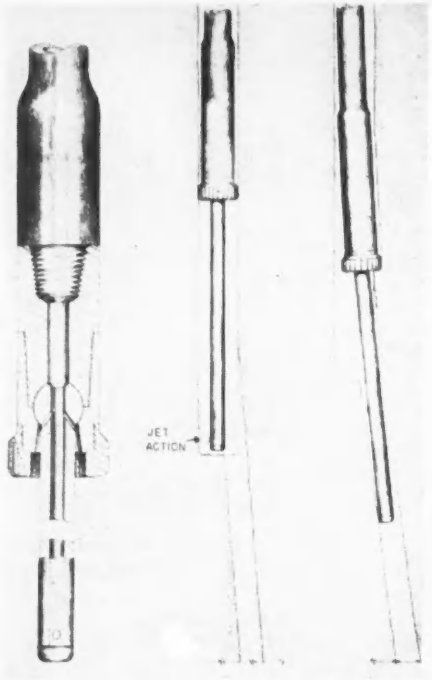


FIGURE 4. Hydraulic pilot diamond reaming bit. LEFT: Cutaway drawing of complete assembly. CENTER: Pilot in position to enter rat hole. RIGHT: Pilot in rat hole and reaming action of diamond bit above shoulder.

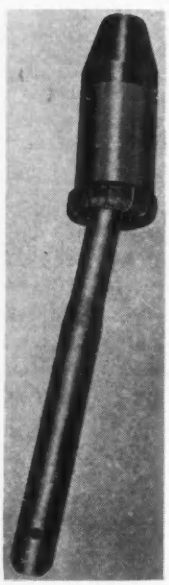
Straightening Jobs in West Texas

To further illustrate the use of directional drilling methods in straightening operations, three examples are shown. These are typical and do not represent the fastest or the slowest job, but are given to illustrate a shallow straightening, a plug back straightening, and a deep straightening job.

The first example is a shallow well drilled in the Goldsmith field in June, 1951. The drift angle at 3790 feet had reached 5° 15′. Three whipstock runs were made and because of an unfavorable mud, did not reach bottom. The mud was conditioned and the fourth whipstock was set by the bottom hole orienting method at 3790 feet in a direction 150 degrees to the right of the direction of the present hole. The actual direction of the well need not be known when using this method of orienting, as all measurements are taken from the low side of the hole. With this system all instruments are run inside of drill pipe, and no lines are used in the open hole. At 3810 feet the drift was reduced to two degrees from vertical. Total time for the job was three days including the first three whipstock runs and the time necessary to get the hole in condition so that the fourth whipstock could reach bottom.

The second typical example is a well, drilled in April, 1951, which exceeded the allowable drift and had to be plugged back. The top of the plug was at 6837 feet where the drift angle was 2° 30′. The first whipstock was 5½-inch outside diameter run in a 6⅛-inch hole and was fitted with a 4½-inch diamond core bit. The whipstock was aligned by the bottom hole orienting system in a direction 170 degrees from the course of the well. The first run failed to sidetrack the plug and another attempt was made at 6864 feet or 27 feet deeper. The drift angle at this point was also 2° 30′ and the whipstock was set 180 degrees from the present course. This run was successful, the plug sidetraced, and the rat hole reamed to full gauge. Normal drilling operations were resumed and on the fourth day the indicator showed the drift at 6911 feet to be 0° 45′.

The third example is a deep well in the Pegasus field where hard formation was encountered, with the result that at 9811 feet the drift angle was 5° 45′. The first whipstock was 5½-inch O.D. and was set in 6¾-inch hole at 9811 feet. This run was made with a diamond bit; however, the whipstock turned in the hole since the rat hole drift picture indicated an increase in angle. A full gauge bit and drill collar was run and the first whipstock sidetracked. The second whipstock was set 180 degrees off the present course at 9831 feet and at 9848 feet the drift angle was reduced from 5° 45′ to 4° 30′. Another whipstock was run at 9861 feet and in the reamed hole at 9886 feet the drift was reduced to 3° 0′. The total time for this job was six days, which included drilling 75 feet of hole and three whipstock runs.



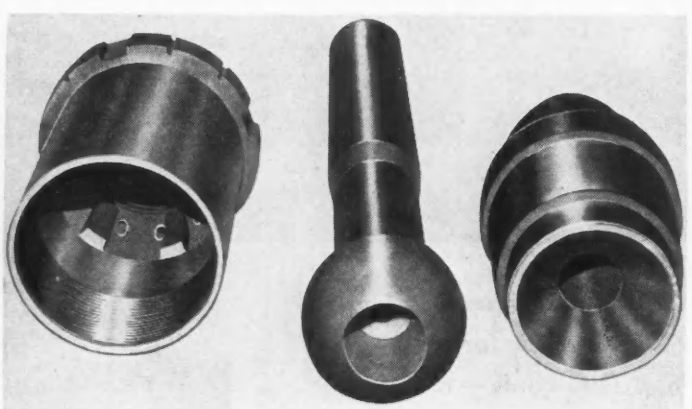


FIGURE 5.
LEFT: Complete hydraulic diamond pilot reamer with ball and socket pilot.

RIGHT: Disassembled view showing, left to right, reaming head, pilot, and sub with ball seat.

Conclusion

The straightening operations which have been discussed in reality consist of the adaptation of directional drilling procedures and tools to a special problem. The same engineering control over the field work and the same limits on maximum allowable doglegs should be accepted for straightening as well as directional drilling. We can expect considerable improvement in applying directional drilling techniques to hole straightening when the tools are properly adapted to the job, and when future experience will permit better planning before the job starts. Actually, we now are beginning to apply the lessons learned on one job to the necessary plans for the next. Great developments in this field can be expected.

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Slush Pump History and Possible Developments

By ROY E. EDWARDS, Gardner-Denver Company

THIS ARTICLE discusses the evolution of mud pump design and field application of present day equipment with torque converter and fluid coupling drives. Trends toward deep drilling presents a need for higher pressure units capable of insuring the efficient circulation of drilling fluid. The utility of multiple cylinder pumps is discussed by the author. This paper was presented before the American Society of Mechanical Engineers, September, 1951, at Tulsa.

SOME form of the churn drill has been used by man since early antiquity. Even the Drake well was drilled with this type in 1859. The real importance of the drilling of this well is that an intensely active period of invention was begun at the time of the oil industry's birth. The method and equipment used in the drilling of this well are of little importance today, except historically. Since the conception of the hydraulic rotary system, as patented by Chapman in 1887, and the drilling of the first well at Spindletop in 1897, it has become the major means of drilling for oil.[1]

Drilling depths have increased from 8046 to 20,521 feet in the past 22 years as graphically indicated in Figure 1,[2] and many wells are now producing below 12,000 feet.

Although the cable tool rig (churn drilling method) has not become obsolete, it would be hard to conceive of drilling to present depths with such equipment, especially when high pressure gas is encountered as in South Texas, Gulf Coast and California operations. As a point of interest, the deepest well drilled by cable tools was 10,086 feet. Surface pressures in some Gulf Coast wells range as high as 9,500 pounds per square inch, and in Eastern Venezuela and Trinidad approach 9000 psi. In such cases the rotary method with its slush pump and circulating system are essential to the control of those gas pressures.

The early rotary system had no pumps. Circulation was established by pouring water into the drill stem from an elevated platform to wash the cuttings through the annulus. Later, while drilling near a windmill, someone thought of connecting the discharge of the windmill to the drill stem to remove the cuttings.[3]

A water well drilling contractor, B. Andrews, Sr., of New Orleans, found that a thick mud slurry would wall up the hole. This was in 1889.[3]

Hence the need for some type of slush pump developed.

Steam Slush Pumps

The next step was to use a boiler feed pump to circulate the cuttings from the well bore. Since steam was the principal source of power at the time rotary drilling began, it was only natural that the first pumps designed specifically for rotary drilling were steam. An early design of rotary drilling pump which incorporated many of the present-day design features is illustrated in Figure 2. Mechanically, the steam pump is a simple device of almost unlimited capacity, the only restriction for oil field use being portability. Pumps having a capacity of 900 hydraulic horsepower and weighing approximately 23,000 pounds were available to the oil industry by the late 1930's.[4] Today, some steam pumps weigh as much as 30,000 pounds, and are capable of working pressures of 4000 psi., with a stalling steam pressure of 400 psi. A volumetric capacity of 1300 gallons per minute, with maximum pistons is available. A cross-section of a modern steam slush pump is shown in Figure 3.

Because of its simplicity, there has been little modification in the design of steam pumps over those of earlier times, except to make them bigger and heavier to withstand the higher loads imposed, and the use of the piston-type steam valve instead of the "D" slide valve. The use of the piston valve was probably brought about by valve lubrication problems caused by the use of high pressures and superheated steam in an effort to obtain more work from a given size of steam

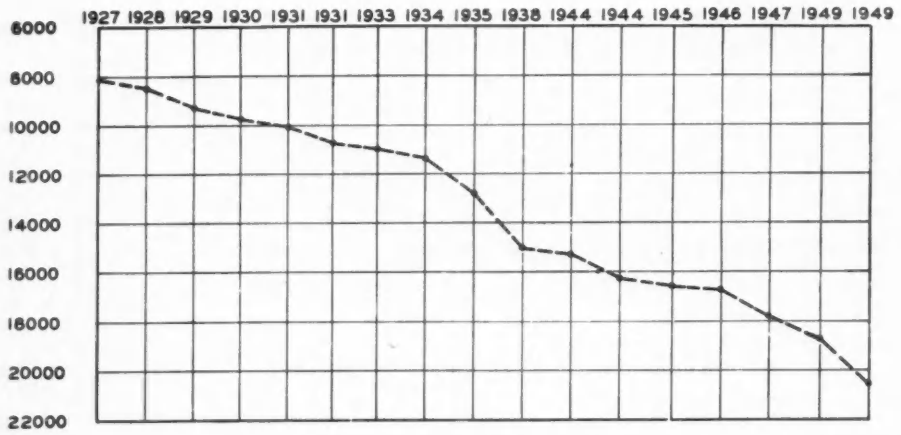

FIGURE 1. Trend of drilling depth.

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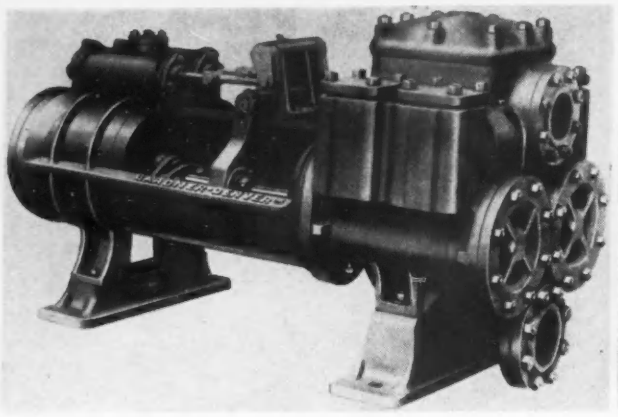

FIGURE 2. Early steam slush pump.

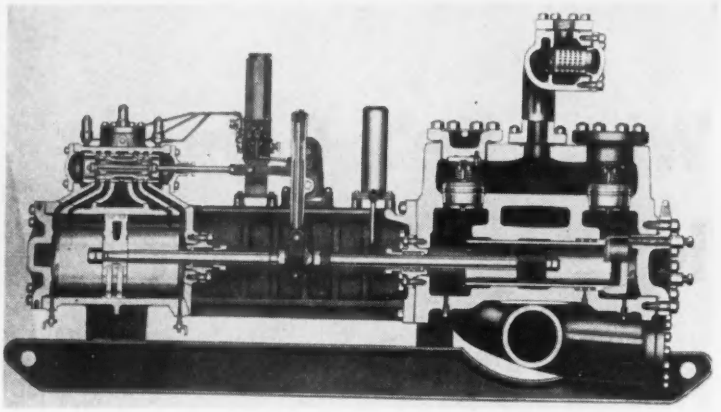

FIGURE 3. Cross-section of modern steam slush pump.

generating unit. However, at least two manufacturers have departed from the conventional or basic design. One manufactures a double-acting triplex steam pump; the other places the rocker stand and piston valve on the underneath side of the pump. The first is to achieve more capacity; the latter to achieve improved mechanical operation.

An additional factor in the favor of the steam pump was the fact that it could be used in multiples (series or parallel operation). Hence the limiting condition was the capacity of the steam generating plant.

Unlimited mechanical capacity was offset by economic limitations such as the high cost of the steam generating plant and the availability of water and fuel.

Power Pumps

As the steam plant reached its economic limit, developments in the field of internal combustion engines had made available a source of cheap power. This brought about the application of the power pump to oil well drilling. The capacity of this type of pump has been steadily increased as drilling depths demanded. Possibly some of this increased capacity was the result of better understanding of the hydraulics of the circulating system and to compensate for losses imposed by the necessary restrictions in the drill stem. Before complete knowledge of the hydraulics of the circulating system was attained, rigs were frequently equipped with pumps of insufficient capacity.[5]

The rate of penetration by the drilling bit has steadily increased as indicated by Figure 4.[6] Possibly a large part of this increase is because of developments in jet drilling within the last few years. Pump output must be sufficient to maintain the required velocity to remove the cuttings from the annulus of the well bore and supply the power to overcome losses in the jet.

In order to obtain some idea as to the trend of slush pumps, the following curves were plotted from current catalog data:

Figure 5 Horsepower vs. stroke.

Figure 6 Pressure vs. stroke, based on master bore.

Figure 7 Pressure vs. stroke, based on smallest rated bore.

Figure 8 Capacity vs. stroke, based on master bore.

From these curves it can be seen that the drilling contractor has a relatively wide range from which to choose a slush pump.

Experiments have been conducted to determine the feasibility of supercharging or pressure flooding the suction of a power pump, increasing the speed and thus obtaining greater volumetric capacity. Although the additional displacement was obtained and valve life was increased, it was gained at the expense of the gears and bearings.

Rated speeds vs. stroke for various pumps available to the industry are plotted in Figure 9. It is wise to stay within the range indicated for the various strokes.

Fluid parts have improved from the beginning as the science of metallurgy advanced and better materials became available. Liners, valves and seats, piston rods and pistons all give reasonable life if the circulating pressures are not too high, and the sand content of the drilling mud is kept within a range of 3 to 8 percent. From those in direct contact with the use of these parts it seems that piston wear (wear of other fluid end parts also) increase at an accelerated rate when pressures exceed 1500 psi. Piston rod wear can be reduced by continually washing the rod with a lubricant or clear water while the pump is running. If the pump is

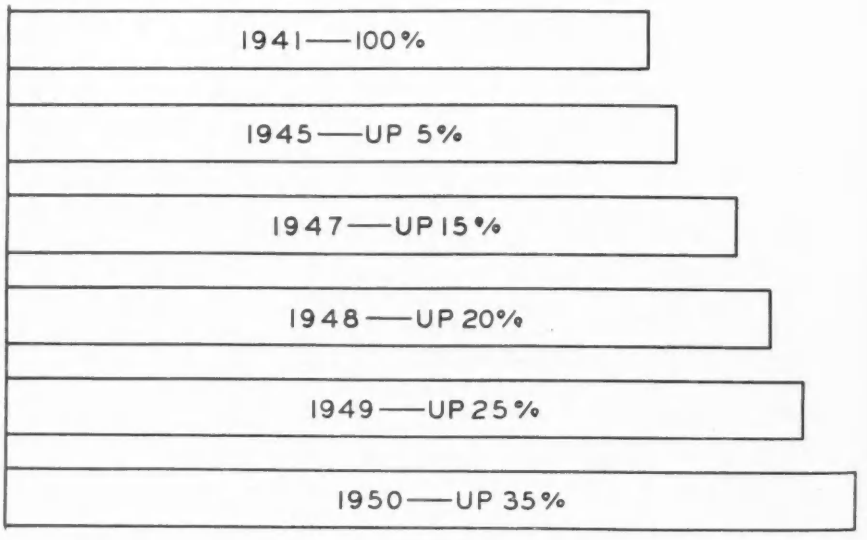

FIGURE 4. Rate of penetration.

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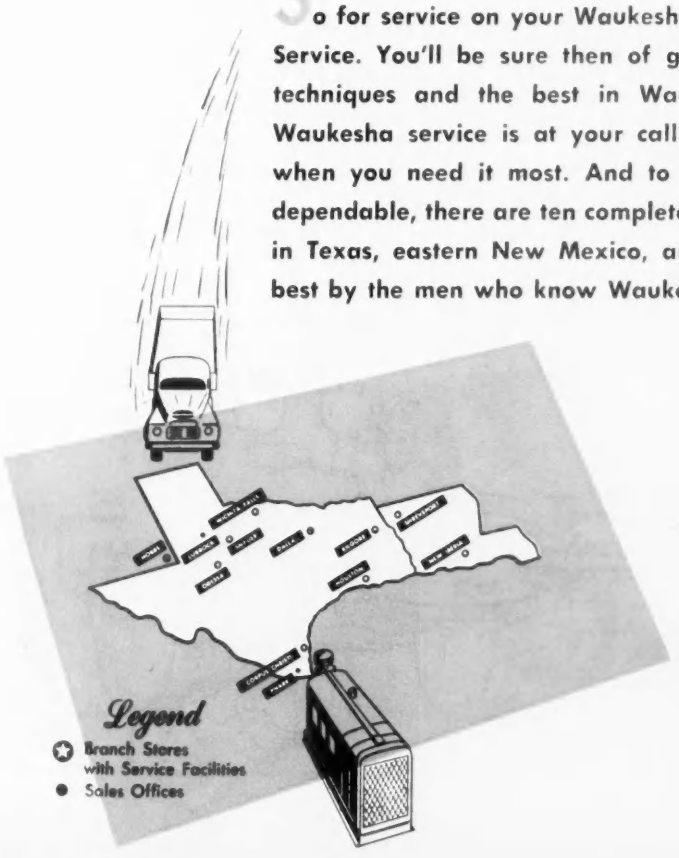

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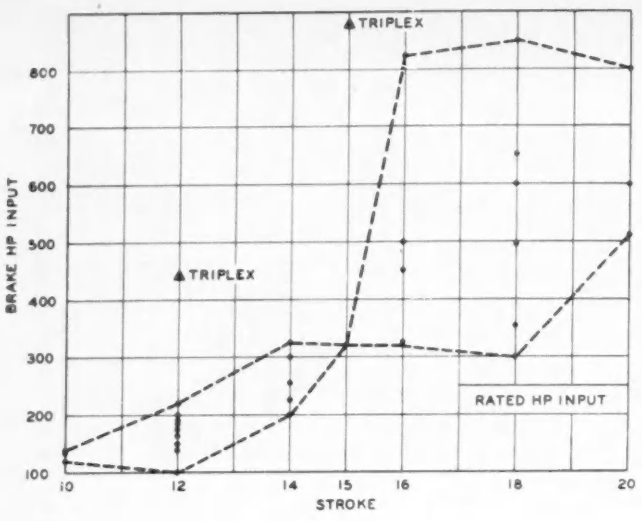

FIGURE 5. Available power pump range. Horsepower vs. stroke.

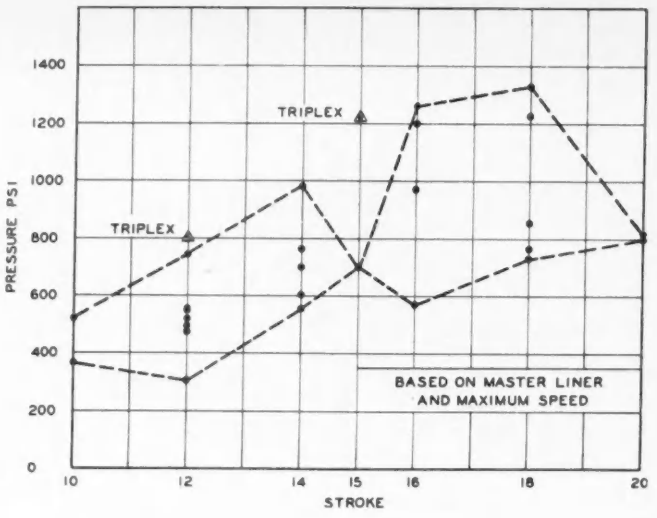

FIGURE 6. Available power pump range. Pressure vs. stroke.

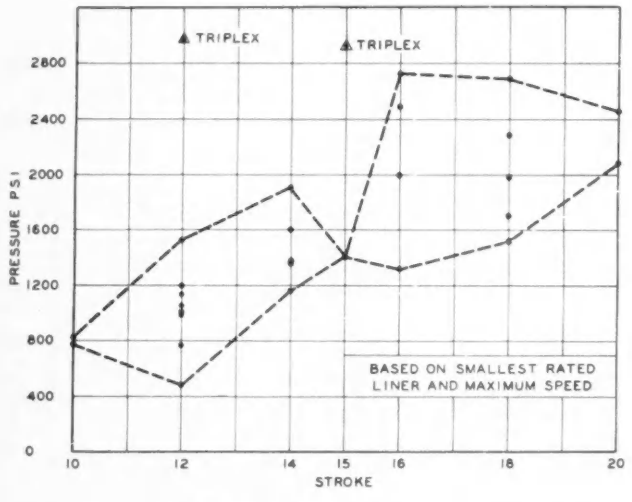

FIGURE 7. Available power pump range. Pressure vs. stroke.

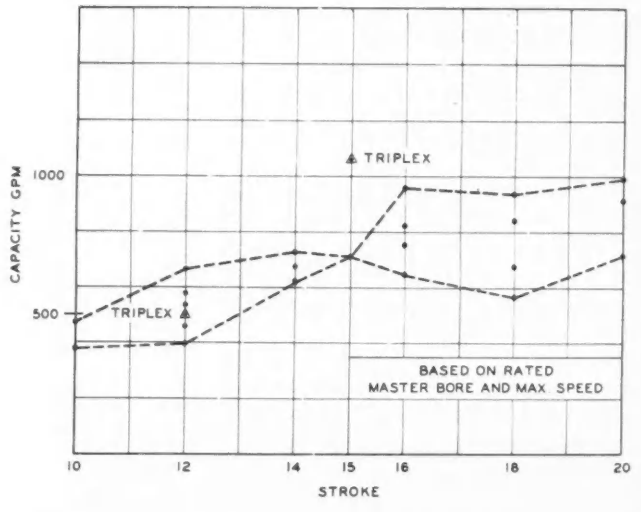

FIGURE 8. Available power pump range. Capacity vs. stroke.

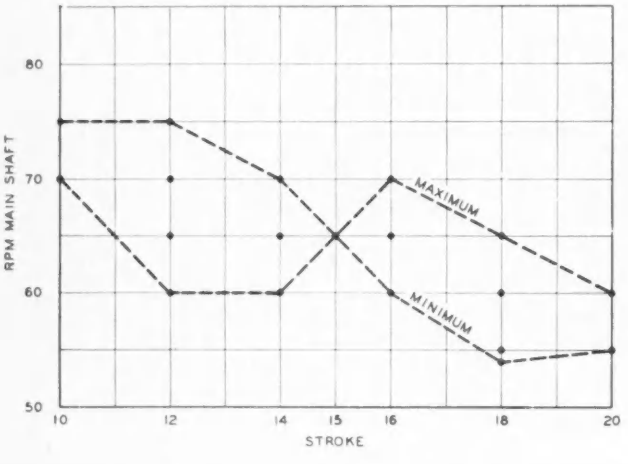

FIGURE 9. Speed range. Mainshaft speed vs. stroke.

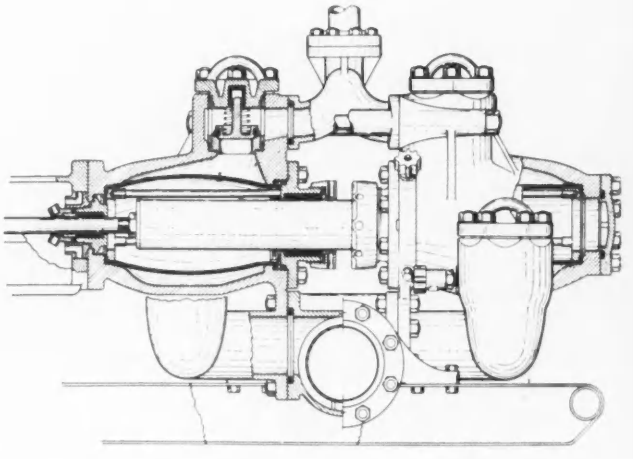

FIGURE 10. Liquid piston fluid end.

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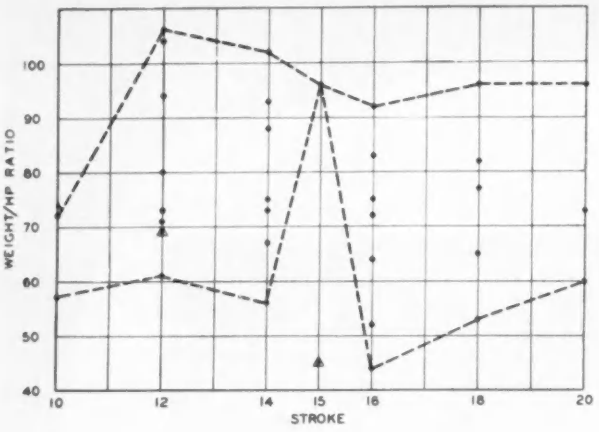

FIGURE 11. Weight/horsepower ratio vs. stroke.

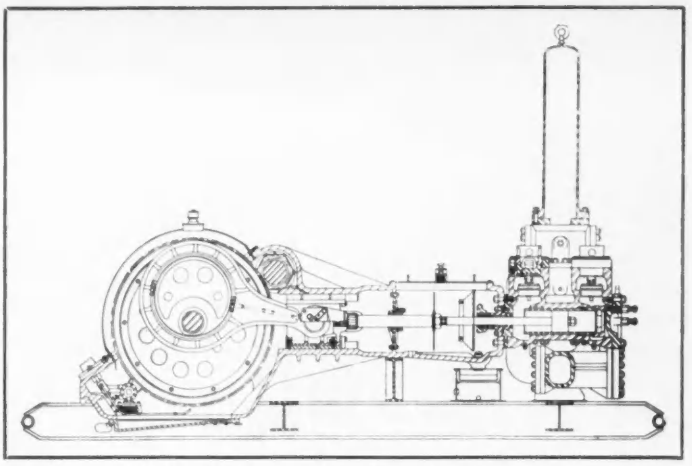

FIGURE 12. Cross-section of modern power pump.

operated within rated speed, valves should give reasonable life, and this life should be increased to some extent if a suction air chamber is used. There is considerable experimental work being done with ceramic plungers and liners. This seems to hold considerable promise for future development. Some users have had excellent results with a self adjusting type of packing (V or Chevron packing) for piston rod stuffing boxes. When using this packing special care must be taken not to tighten it too much.

An interesting attempt, not now on the market, to eliminate wear from the abrasive action of the mud on the fluid end parts is shown in Figure 10. Careful attention would have to be paid to leakage of the fluid surrounding the plunger.

The industry is ever seeking improvement in equipment and means for obtaining more work from a given piece of equipment. One manufacturer of slush pumps has produced a double-acting triplex pump to reduce the effects of pump surging, and in an effort to get more work with less weight. Another concern built a six-cylinder horizontally opposed plunger pump for experimental purposes. It was never commercially exploited. Recently several companies have been assisting in research in connection with a variable volume pump invented by J. E. Smith of Houston. An advantage claimed for this type of pump is that it will automatically accommodate itself to the demands of the circulating system, consistent with the power input. A 500-horsepower pump of this design weighs approximately 18,000 pounds. Another manufacturer is experimenting with a chain drive instead of the conventional gear drive in an effort to gain a decrease in weight. In contacting various sources the one thing mentioned most, as a possible improvement in slush pumps, was "More horsepower with less weight; make them lighter but stay within economical limits." Today several manufacturers are fabricating pumps by welding the power end. Others are redesigning older models and are using alloy steel fluid ends to meet the demand. Figure 11 shows the present trend in weight horsepower ratios plotted against stroke.

Modern mechanical improvements are interchangeable right and left fluid cylinders, combination splash and force feed lubrication, screwed type valve covers and cylinder heads, one-piece connecting rods, double baffles to keep the mud out of the power end (this is one of the main causes of power end failure), lubricated piston rod stuffing boxes, and hammerup nuts for piston and extension rods. A cross-section of a power pump incorporating some of these features is shown in Figure 12.

In an effort to obtain more work from power pumps, they are now driven with two-speed drives, torque converters (see Figure 13), scoop controlled hydraulic couplings, and in series and parallel operation. The two-speed drive and the converter will overload a pump. This is especially true when liners are not changed as circulating pressures are increased, a practice now in frequent use when using these torque multipliers. Prolonged use of this type may result in failure, depending of course on the conservativeness of the design. The reason for this is that although the frequency and effect of the dynamic loads may be decreased, the "static" phase of the loading is multiplied several times. Couplings of the scoop controlled type are rather expensive

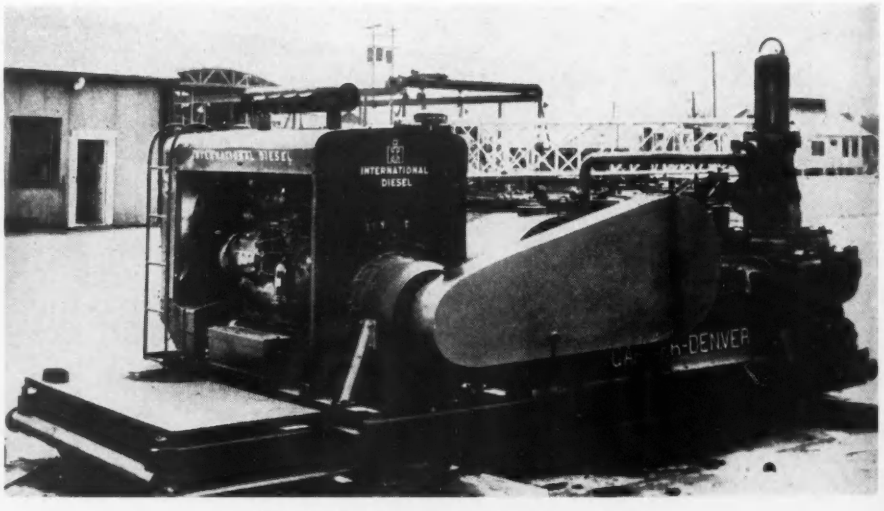

FIGURE 13. Torque converter pump drive.

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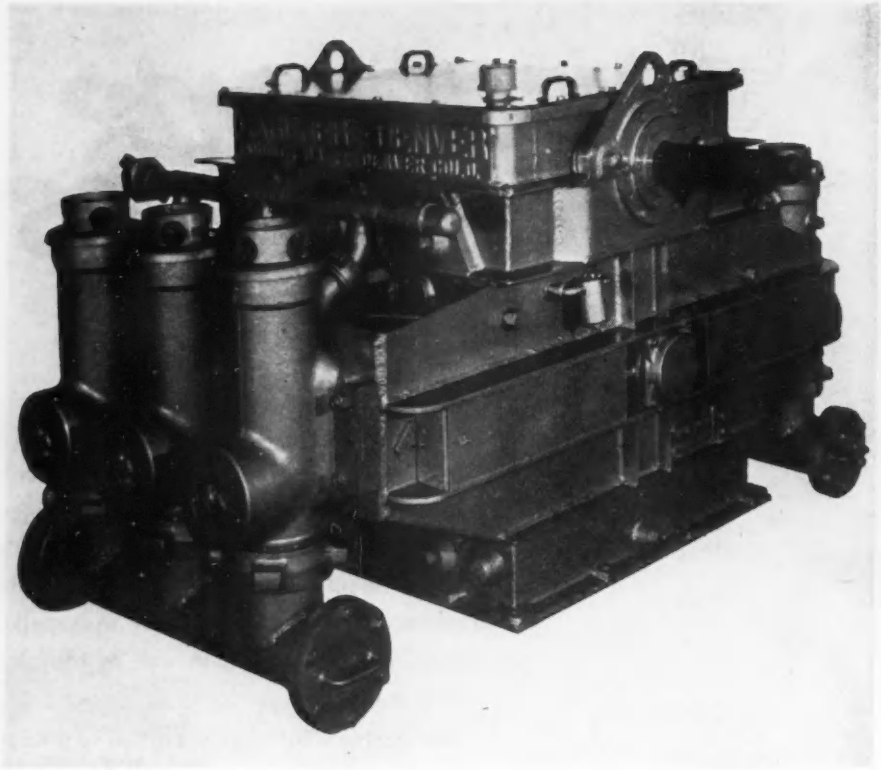

FIGURE 14. Six-cylinder plunger pump.

for application to a pumping unit alone. If incorporated in the design of a complete rig, the advantage of speed control without overloading the pump is available. Considerable flexibility can be had by using series-parallel operation without overloading the pump because the load imposed on the piston is equal to the differential load across the piston when the pumps are connected in series. This type of arrangement affords large volumes for top-hole drilling and high pressure for deep drilling. When several pumps are driven by a coupling, either scoop controlled or conventional, and have the proper type of surge chamber on the discharge they can be successfully operated in series.

The number of pumps used per rig depends on the hydraulic horsepower required and potential drilling hazards. In California one contractor uses a single torque converter driven pump down to 5000 feet and two converter driven pumps to 8000 feet. On the Gulf Coast one firm uses three steam pumps for deep drilling (two main pumps and one mud mixing pump), and on big power rigs they use two big power pumps. On smaller power rigs they use one main pump and a smaller one.

A multiple cylinder high speed plunger pump that offers possibilities in deep drilling as a stand-by has been on the market for some time. This pump has been popular as an oil well cementing pump, as a workover unit for oil wells, and for handling mining sludge and mine dewatering. It has been used as a mud pump, and several concerns are experimenting with it for this purpose. This six-cylinder pump (Figure 14) is in reality three pumps combined in one. Three plungers have a diameter of 4¾ inches and three have a diameter of 3½ inches. It is possible to use either set selectively or both in combination. Table 1 gives the range of capacity. This pump is designed to take the severe overloads that can be imposed by a torque converter, and when used with the one the range is extremely flexible. It could be used for mud mixing, rig wash down, to break circulation, or in any extremely high pressure operation required on a rig; also in marine and foreign operations, where rental equipment is not readily available it would have considerable advantage.

Conclusions

- The steam slush pump is limited by the steam generating plant.
- Lighter pumps for the same horsepower are in demand.
- Improved mud pumps are necessary to meet the demands of deeper drilling. Since drilling rigs are predominately powered by internal combustion engines and consequently require power pumps, it is along this line that manufacturers are continually striving to improve.
- It appears that for deep drilling with power pumps, hydraulic drives and series-parallel operation probably will be used more extensively.
- The use of the converter drive may require a new method of rating power pumps.
- A plunger pump is available to the industry for possible application to drilling operations and that has extreme flexibility.

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TABLE 1

Theoretical Capacities and Pressures for PL-7 Six Cylinder Plunger Pump

Jack Shaft, RPM	Main Shaft or Pump RPM	QUANTITY AND SIZE OF PLUNGERS IN OPERATION							
		(6) 4¾x7		(3) 4¾x7		(3) 4¾x7 (3) 3½x7		(3) 3½x7	
		GPM	PSI	GPM	PSI	GPM	PSI	GPM	PSI
750	125	408	945	204	1890	310	1244	109	3538
720	120	396	974	198	1948	298	1294	105	3672
660	110	356	1083	178	2166	274	1411	96	4016
600	100	321	1201	160	2410	248	1555	87	4435
540	90	288	1339	144	2678	224	1721	77.5	4976
480	80	258	1456	129	2912	199	1938	70	5508
420	70	225	1714	....	....	174	2216	61	6320
360	60	193	1998	....	....	149	2588	52.5	7344
300	50	160	2410	....	....	124	3110	41.5	9292
240	40	129	2989	....	....	....	....	35	10000

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LOST CIRCULATION— Causes and Remedies

By H. J. SHUMATE

Zone Drilling Engineer, Gulf Oil Corporation

THE PROBLEM of lost circulation has become more serious with drilling to greater depths and expanded wildcatting activity. The author lists the generally known types of lost circulation and prescribes possible solutions. This paper was presented at the 11th annual meeting of the American Association of Oilwell Drilling Contractors, Fort Worth.

"WHAT can we do about Lost Circulation?" is a question becoming more common each day, as wells are drilled deeper in an effort to maintain adequate reserves in face of the increasing demands of the national economy and the preparedness program.

As the deeper zones are penetrated with greater regularity, lost circulation assumes the menacing proportions of a malignancy consuming an increasing amount of rig time, manhours and money. Lost circulation is not new; it is as old as the rotary drilling industry which is now spotlighting it, but it becomes more serious as we are forced to greater depths and more expansive wildcatting programs.

Lost circulation may be divided into two classes: first, those of a mechanical nature resulting from drilling techniques employed; second, those inherent in the formation and merely awaiting penetration of the bit.

The mechanical type is considered to be an artificially induced loss, caused by employment of high density muds used for drilling abnormal pressure zones; pressure surges resulting from pipe movements, balling, high gel strengths, pumping methods, reduced annular clearances, or a combination of two or more of the conditions listed.

Losses of the second type may occur when drilling loosely consolidated sands or uncemented gravel beds, lime rocks containing solution (sometimes cavernous) porosity developed by exposure to water, and cracks or fissures resulting from earth stresses. Mechanical factors are, of course, present and exert a strong influence on the gravity of the second type of loss, though some may be held to have been unavoidable by virtue of their inherent characteristics.

In an attempt to combat the terrific expense of lost circulation attendant on drilling in zones of known abnormal pressure along the Gulf Coast of Louisiana and Texas, an intensive study of the character of these losses was begun. The most effective remedy for lost circulation is, of course, to prevent it, but before this could be done a proper diagnosis had to be made.

It had been noted that, in many cases of loss, the hole would remain full and sometimes it was possible to restore circulation by the simple expedient of making a trip to change bits, time alone seeming to make the necessary repairs to the hole. In other instances the loss had been preceded by a perceptible slowing of the pump, indicating a restriction in the flow of the mud. These factors lent weight to the theory that fractures were being created by an excessive pressure greater than the tensile strength of some of the formations to which it was exposed.

Engineers were assigned to a test well in the Peach Point field of Brazoria County, where high density mud would be required and equipment was installed for recording mud weight, pit level, drilling speed, circulation rate, bit weight, pump pressure, pump strokes, rotary speed and rotary torque. There were 22 instances of loss recorded during the drilling of this well, and 14 were found to be directly associated with balling or movement of the drill pipe.

In the majority of these losses the hole remained full, indicating the formations were capable of supporting the 17.5 pounds per gallon mud being used, and that pressures in excess of the hydrostatic pressure were being required to rupture the formation.

Information as to the magnitude of pressure surges resulting from pipe movements was not available, so a decision was made to determine the connection these movements might have with mud losses.

A sub was made to replace the bit in the drill string and two recording pressure gauges were attached. Tests were run inside casing to determine effects of rapidly running and withdrawing drill pipe, spudding while pumping, and rapid opening of pumps to start circulation. Pressures obtained were equivalent to an increase in mud density of 1.3 and 2.3 ppg, respectively, during rapid lowering of one stand of pipe and rapid lowering of the kelly while pumping. Pressure surges equal to one-third ppg increase over initial circulation pressures occurred when the pump was opened wide immediately on starting circulation. Pressure decreases, due to withdrawals, were not great, usually being less than 50 pounds per square inch at all depths.

These surge tests were conducted in oil-emulsion muds of low viscosity, low gels and low density, and obviously would have been of a higher order in fluids of less favorable character.

As a result of the information obtained from the test wells, plans were made to employ drilling techniques that might serve to reduce the frequency of losses in the next abnormal pressure well.

The well chosen for the trial effort was J. F. Perry Unit 1, Peach Point field. Oil-emulsion mud was used to eliminate balling by preferential wetting of the drill string. Increased annular clearances were obtained by use of streamlined drill pipe and removal of the rubber protectors. Reduction in pressure surges was made possible by slowing the entry of the drill pipe in the hole from the normal 15-second-per-stand running time to 35 or 40 seconds; by starting the pumps after the kelly was lowered; by adoption of a no-spudding rule; and by slowly opening the pumps when circulation was started.

Successful completion of the well without a single loss of circulation, as compared with a previous history of 79 losses on three prior wells in the same field, gave ample justification for the control methods employed.

Losses of circulation occurring in porous, cavernous or fractured formations are difficult to avoid, sometimes difficult to cure, and, in extreme cases, have been known to result in abandonment. Losses of this type are prevalent in the Permian Basin.

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quent losses are encountered in the Midland Basin. The increased tempo of drilling occasioned by Spraberry, Pennsylvanian and Ellenburger discoveries has resulted in this becoming the most active area in West Texas, and costs attributable to lost circulation have mounted greatly.

Wells drilled on the Central Basin Platform lose mud regularly in zones containing solution porosity, while the Delaware Basin, which has not yet been widely explored by deep wildcatting, promises to be equally interesting and difficult to drill when activity in that area increases. The majority of the deep wells drilled in the Delaware Basin have reported trouble in maintaining circulation, and some of these losses have been severe in the extreme. One well that penetrated the Ellenburger on the western side of the basin reported 46 losses, totaling 12,985 barrels of mud. Worthy of note is that the mud never weighed over 9.0 ppg and contained at all times as much sealing material as the pumps could handle.

It has been stated before that lost circulation is either mechanical, and caused by drilling methods, or arises from conditions inherent in the formation which, in many instances, have been aggravated by mechanical factors.

Once a loss has occurred, interpretation must be made before the proper remedial procedure can be undertaken. Instruments recording pit level and pipe movements are particularly helpful in making this interpretation, but if the loss is of a serious nature knowledge of the point of loss should be obtained if possible.

The following methods for determining the point of loss have been used:

1. Temperature Survey. Requires forcing mud out of the hole by pumping cool mud from the surface. This method is expensive and has brought inconclusive results.

2. Radioactive Tracer. Has been added to the mud and pumped down the drill pipe along with remedial squeeze mixtures, followed by a gamma-ray survey. This resulted in radioactivity being scattered throughout the mud system and wall cake, and was discontinued because of negligible results.

3. Spinner Survey. This method has proved most helpful, but requires large volumes of mud, and is ineffective where large quantities of sealing materials are present. It is sometimes necessary to displace the entire volume of the hole from the top with mud containing no sealing materials before a reading can be obtained.

4. Resistivity Survey. An electrical survey employing the principle of resistivity has lately been developed that gives promise of locating the point of loss without much waste of mud. It has particular significance in that it is not subject to clogging with sealing materials or shale particles. The author observed the use of this instrument on a well bottomed at 10,432 feet, where two points of loss were established. The first loss was from 7925-50, and the second from 8340-50. The survey required only two hours of rig time and 160 barrels of mud for running.

When interpretation as to cause has been made, curative measures are selected. Some of the most promising remedies are listed, not necessarily in order of importance:

1. Sealing Agents. The use of sealing materials is usually the first method employed, and in losses to zones of low permeability are usually adequate. Concentrations ranging from 5 to 35 pounds per barrel are commonplace. More than one type is necessary to achieve a variety of patterns and an effective gradation in particle size.

2. Equalization Cementing. This procedure has especial significance in West Texas, where the fluid levels frequently drop considerable distances down the hole. The mud level is determined by running a float or short piece of spinning chain on a measuring line down the inside of the drill pipe. Calculation of the hydrostatic head is then made from the known weight of the mud. Tubing or drill pipe is then placed at a sufficient height above the loss so that when the cement and the displacing fluid reach a point of equalization about half of the cement will remain in the hole to be drilled out.

3. Diesel Oil-Bentonite Squeeze. This method necessitates use of a cement truck for mixing approximately 300 pounds of bentonite per barrel of oil, and is pumped through the drill pipe to a point just above the loss where it is permitted to contact the water or mud in the hole. At contact with the water or mud the oil is forced out and the result is immediate hydration of the bentonite, which then forms a tough plug capable of sealing off a large loss.

An interesting variation consists of mixing 300 pounds of gypsum cement in a barrel of oil and following the procedure outlined above. If the thief formation is dry, it would be necessary to pump water into the formation ahead of the mixture to provide the proper hydration fluid. This adaptation offers a way to overcome the time and temperature factors controlling the setting of this cement. Since no hydration takes place in the oil, it will remain pumpable for any length of time that it is not in contact with water or mud. It is necessary to pump oil spacers ahead and behind either type of mixture, to avoid plugging the drill pipe. Best results are obtained from a ration of four barrels of squeeze mixture to one of the hydrating fluid.

4. Oil-Emulsion Muds. One of the most important developments in the rotary drilling industry of the last few years has been the increased use of oil-in-water type emulsions for better drilling fluid control. Chemical emulsions made from water-base muds to which 10 to 15 percent by volume diesel oil, containing a soap emulsifying agent, has been added have enjoyed signal success in elimination of balling and reduction of pipe drag, rotary torque and circulating pressures in soft shale formations.

Emulsions have been slower to come into favor in West Texas than on the Gulf Coast, because electric logs do not give as complete a picture as they do on the coast, hence the Permian Basin geologist is forced to rely mainly on surface examination of samples and drill-stem testing done as a result of this examination.

Since fluorescence in the samples is one of the important conditions upon which drill-stem tests are based, artificial fluorescence imparted to the samples by oil in the mud could prove costly on wildcat wells.

In field wells where geological control has been established, both stable and mechanical emulsions are gaining recognition as an aid in reduction or prevention of circulation losses. It is possible by the use of oil to maintain muds as light or lighter than water, and this is of particular significance in wells which will not even support the weight of water.

Current steel shortages have made it necessary to curtail the use of casing, and by use of crude oil to reduce weight operators have been able to eliminate the salt strings from their casing programs in some of the Spraberry sand developments. Open salt sections produce a mud that will weigh in excess of ten ppg when complemented by formation solids. In an area where 9.0 ppg mud is the maximum fluid weight that it is possible to circulate, addition of 25 to 40 percent crude and a small percentage of zeolite clay has enabled operators to achieve the drastic weight reduction necessary. A better emulsion will result if two or three pounds per barrel of starch is also added. Defoaming agents are usually necessary in these muds, the most effective of which is

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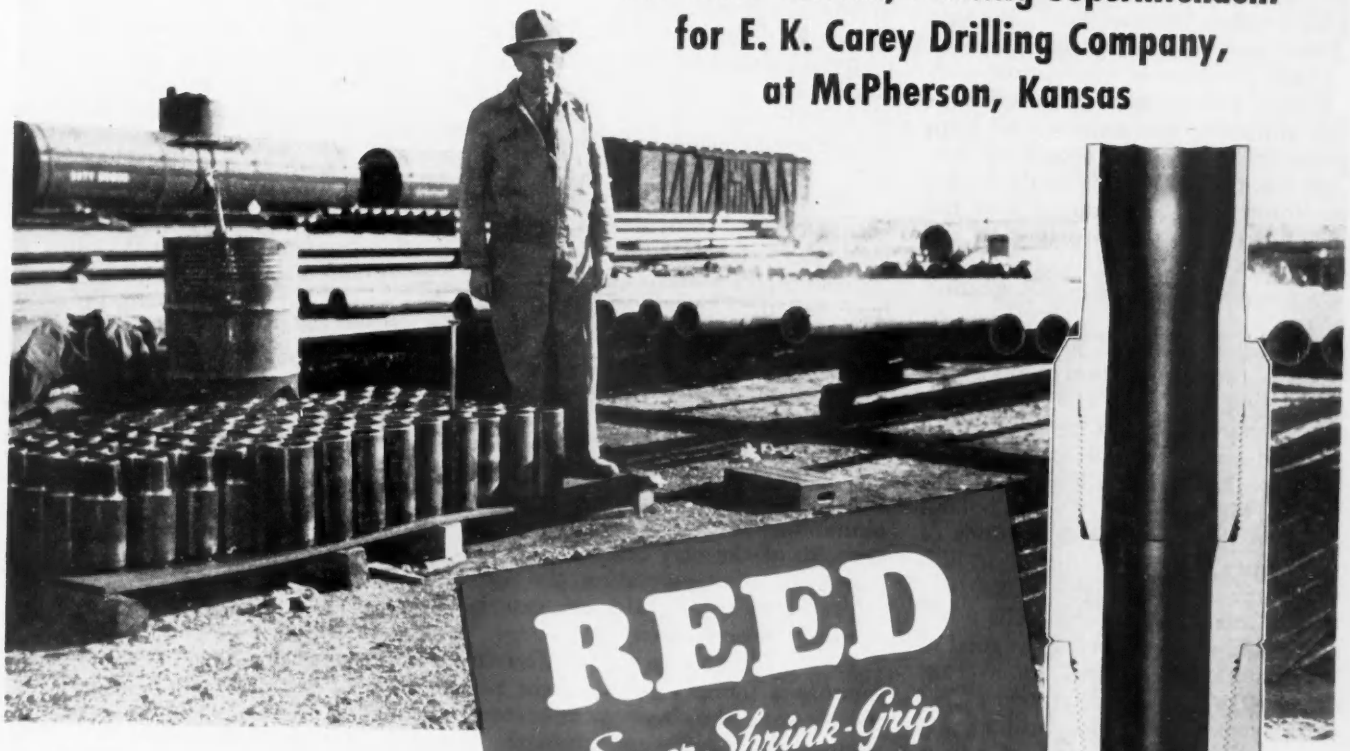

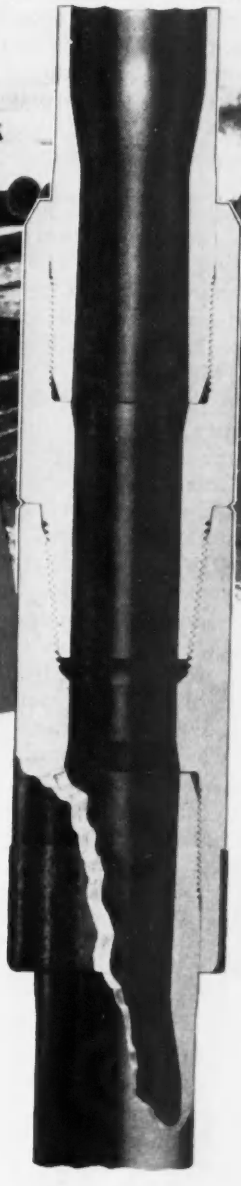

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5. Drilling With Gases. The author was privileged to observe a well drilled with compressed air in Martin County, Texas, and also wells using gas in the San Juan Basin of northwestern New Mexico.

On the Martin County well air was provided by portable compressors in two stages of compression and injected into the well at a rate of about 40,000 cubic feet per hour. Because of the low volume it was necessary to drill by reverse circulation with 2⅜-inch tubing, and then considerable difficulty was experienced from plugging. The entire Spraberry section was drilled by this method with no liquid being introduced into the hole other than that provided by the formation itself. A total of 922 feet was made with 20 bits in 148 rotating hours.

In the Blanco gas field of New Mexico, the introduction of gas as the circulating medium has met with spectacular success. Operators were plagued with so much trouble from lost circulation in drilling the Cliff House, Menefee and Point Lookout sands in the Mesa Verde sections of the Upper Cretaceous that mud bills sometimes ran as high as $20,000, and it was felt that the wells when completed were not nearly as good as they should have been. An average of some 1½ million cubic feet of gas per day is required for drilling and keeping the hole clean and, of course, lost circulation has been eliminated. On one well observed by the author, 822 feet of hole was made with two bits in 27¾ hours, and only 19½ hours was actual rotating time on bottom, the other 8¼ hours being spent in reaming, jetting and making connections. Mud used on this well amounted to the ridiculously low figure of 47 sacks of bentonite for spudding. Before introduction of gas drilling, average drill-in time with mud ranged from 10 to 14 days, and 10 to 14 bits.

Now to return to the question "What can we do about lost circulation?" Obviously, lost circulation can never be entirely eliminated, but by a well-planned attempt to control the mechanical factors contributing to it, much may be done to reduce the severity and frequence.

Pressure surges may be found to be causing loss in critical wells. Where trips are numerous, it might prove costly to increase the amount of time going in the hole, but if evidence can be supported proving new losses or rupture of old ones (as in the case of porosity coated with sealing materials) from rapid lowering of drill pipe, arrangements for suitable compensation could probably be made with the operator. Further, there seems to be no reason why circulating pumps cannot be opened slowly, or why the pumps should need to be kicked in before the kelly is lowered after having made a routine mouse hole connection.

There is one more suggestion which might ultimately prove beneficial to both the operator and the contractor, and which the author believes should merit careful consideration. This is that one of the most pressing needs of the drilling industry is the formation of some sort of group to act as a clearing house in gathering and disseminating information relative to losses, their character, and the remedial procedures used, both successful and unsuccessful. For maximum benefit, these groups should function, primarily, on a sectional basis, where the nature of the losses and the curative techniques employed would be similar.

All too often, such factual data cannot be obtained because of a reluctance on the part of all concerned to release any information which might cause criticism of individual methods. It should be realized that seemingly incurable losses are not individual, but are happening to everyone engaged in the drilling industry.

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New Products Reduce Problem of Lost Returns

THE multi-million dollar problem of lost circulation will be simplified through the field application of two new products recently introduced by Magnolia Petroleum Company's Field Research Laboratories. One product, known as clay cement, is designed to close off the permeable zones in which losses occur after they are encountered by the drill bit. The other material consists of leather fiber and can be used in many places to seal off troublesome subsurface formations encountered during a drilling operation.

The new time-setting cement has been successful in field tests for plugging thief formations when other conventional materials and techniques have failed. The successful application of the product obviates excessive requirements of casing, cement, rig time and the blowout hazards attendant to lost circulation.

Basically, the new clay cement consists of an aqueous slurry of specially selected clay, a smaller amount of an aluminum silicate to increase the strength of the clay after it sets, and a retarder for increasing the time during which the slurry can be pumped before it hardens.

In a relatively short time after the mixture is pumped down to the permeable zone, the clay cement becomes plastic with sufficient strength to seal off the zone against mud losses during subsequent drilling operations.

Field tests of the clay cement were made where conventional plastering and bridging materials were ineffective and where, normally, cementing would be indicated. Cementing, as applied for such purposes is expensive and troublesome.

A technique for displacing the slurry includes use of standard cementing equipment where the solids and water are jet-hopper mixed and then pumped directly into the drill pipe. In certain areas, particularly in application to shallow loss zones, it should be feasible to utilize regular mud pumps and eliminate the need for cementing equipment.

The leather additive has been found to offer outstanding results in formations not presenting a lost circulation problem of sufficient caliber to command application of clay cement. A typical situation where this new leather fiber can be used occurs when a drill bit penetrates a formation of loose or unconsolidated material and permits a flow of water, oil or gas into the well bore. Frequently, when such conditions have been encountered it has been necessary to discontinue drilling operations until the formation has been effectively sealed.

Extensive laboratory tests have shown that the leather fibers will adhere to the particles of the formation to clog the apertures and seal the walls of the hole after it has been added to the drilling mud.

When employed in drilling muds of a highly alkaline nature, the leather will be disposed of within 24 hours, and will dispense with any need for screening the mud after the sealing process is completed.

Appraisal of Drilling Mud Costs

Part 2 (Conclusion) – The cost analysis method as applied to appraisals of individual well mud costs

By VICTOR V. HORNER

Baroid Sales Division, National Lead Company, Tulsa

A PARTICULAR semi-wildcat well was reviewed for appraisal of mud costs. It was the purpose of the analysis to evaluate the mud expenditure to determine whether the cost was excessive. Former methods for such an evaluation employed well to well comparison. However, in this case, drilling depths and conditions varied considerably within the area, and a well to well cost comparison had little meaning. The following analysis illustrates the application of the method heretofore described:

WELL STATISTICS:

1. 13⅜-inch casing set at 572 feet; cost of spud mud $190.

2. Salt water type mud 572 feet to 3518 feet; 12¼-inch hole; 600 barrels mud volume at 572 feet; 1100 barrels mud volume at 3518 feet; 850 barrels average mud volume; 9⅝-inch casing set at 3518 feet; 12 drilling days on mud; cost of materials $1185.

3. Bentonite - caustic - quebracho mud 3518 feet to 8905 feet (total depth); 8¾-inch hole; 900 barrels mud volume at 3518 feet; 1300 barrels mud volume at 8905 feet; 1100 barrels average mud volume; 64 drilling days on mud; cost of materials $5424.

4. Total well mud cost $6799 (invoiced).

Assuming normal hole enlargements for the area, and unit mud costs for the type of mud used (reasonably estimated from pilot testing and mud treating experience) and using the record of mud material costs, a material balance was set up and the dilution factor calculated.

1. Spud mud for surface. $190

2. Salt water type mud (572-3518 feet).

(a) Final mud volume cost = 1100 bbl. × $0.30* = $330

(b) Maintenance = $1185 − $330 = 855

(c) Dilution factor = $1,185 / $855

$$\frac{\$855}{850 \text{ bbl.} \times 12 \text{ days} \times \$0.30} = 28 \text{ percent}$$

3. Bentonite, caustic, quebracho mud (3518-8905 feet).

(a) Final mud volume cost = 1300 barrels × $0.65 (estimated unit mud costs for this type mud) = $845

(b) Loss of circulation cost:
Materials (invoiced) = $1,018
100 barrels mud at $ 0.65 per barrel = 65 $1,083

(c) Maintenance = $5424 − ($845 plus ($1083) = 3,496 5,424

(d) Dilution factor = $3,496 / (1100 bbl. × 64 days × $0.65) = 7.6 percent

Total Well Mud Cost $6,799

By examining the dilution factor of 28 percent for the salt water mud and 7.6 percent for the chemically treated mud, it was concluded that these dilution rates were extremely reasonable for this type of drilling, and that this total mud cost was well in line.

Another well in this general area involving three different mud types was similarly analyzed.

1. Salt water.
2. Bentonite, caustic, quebracho.
3. Bentonite, caustic, quebracho, sodium carboxymethyl cellulose.

Total mud cost $15,008.

WELL STATISTICS:

1. 16-inch casing set at 489 feet, cost of spud mud was $196.

2. Salt water type mud 489 feet to 3453 feet; 12¼-inch hole; 750 barrels mud volume at 489 feet; 1300 barrels mud volume at 3453 feet; 1025 barrels average mud volume; 10¾-inch casing set at 3453 feet; 13 days on mud; cost of materials $1005.

3. Bentonite, caustic, quebracho mud 3453 feet to 7500 feet; 8¾-inch hole; 950 barrels mud volume at 3453; 1150 barrels mud volume at 7500 feet; 1050 barrels average mud volumes; 41 days on mud.

4. Bentonite, CMC, caustic, quebracho mud 7500 feet to 11,436 feet; 8¾-inch hole; 1150 barrels mud volume at 7500 feet; 1425 barrels mud volume at 11,436 feet; 1288 barrels average mud volume; 92 days on mud.

5. Total cost of bentonite, CMC, caustic and quebracho used from 3453 feet to 11,436 feet = $12,473.

6. Loss of circulation material only, total cost $1334.

7. Total well mud cost $15,008 (invoiced).

Assuming normal hole enlargements for the area; the same unit mud costs for the salt water type and bentonite, caustic, quebracho muds as used in the previous well; $0.85 per barrel unit cost for the bentonite, CMC, caustic, quebracho mud used from 7500 to 11,436 feet; and the actual mud material cost, a material balance was set up and the dilution factor estimated.

1. Spud mud for surface.

2. Salt water type mud (489-3453 feet).

$196

(a) Final mud volume cost = 1300 bbl. × $0.30 = $ 390

(b) Maintenance cost = $1,005 − $390 = 615 1,005

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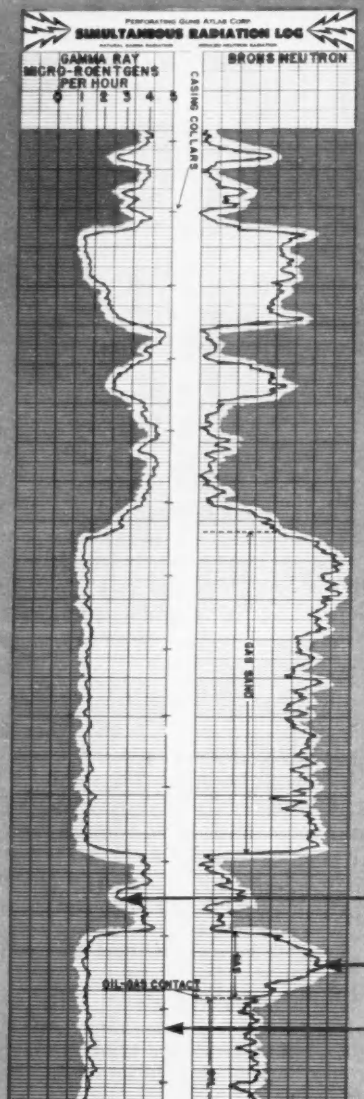

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an understanding of oilfield atomic energy in 5 minutes reading time

You can't fool all of the people all the time . . . not even with wild claims. So, let's call a spade *a spade!* Let's see why these wild claims are never supported by some plain, honest-to-goodness, understandable *facts* on the science of atomic energy as employed in well logging. Then, *you* be the judge!

use of a small ionization chamber to obtain the so-called Neutron Log (but which, actually, is a Neutron/*Gamma* Log) . . . whereas PGAC enjoys patent protection in the *exclusive use* of the afore-mentioned Slow-Neutron counter to obtain a "pure" Neutron/Neutron log.

The ionization chambers used in all competitive Neutron logging, are responsive only to Gamma Rays of various types—not to Neutrons of any type. Neutron/Gamma Logs are intended to reflect the detection of *secondary* Gamma Rays-of-capture ONLY (which result from Neutron bombardment of the formation being logged) . . . and it should be remembered that this *secondary* Gamma radiation is the only phenomenon which can be utilized by competitive methods to obtain their Neutron/Gamma logs. It is a scientific fact, however, that the logging of this one phenomenon *alone* is utterly impossible, because two other phenomena are *always* present—and these other two are decidely detrimental to obtaining an accurate Neutron curve.

The first of these two detrimental phenomena is the *natural* Gamma radiation from the formation being logged. Under normal logging conditions, this *natural* Gamma radiation may be of low magnitude and not present too much of a problem. However, many instances are known where strong *natural* radiation from the formation being logged could overshadow the vital *secondary* Gamma radiation and cause an erroneous log.

The second detrimental phenomenon is the strong, scattered, *primary* Gamma radiation which results from the Neutron source itself, simply because there is always a very strong radiation of Gamma Rays present in the bombardment source. To prevent this strong *primary* Gamma radiation from completely blocking out the *secondary* Gamma radiation — from which the log must be obtained — all competitive Neutron logging instruments are forced to use a shielding between the Neutron bombardment source and the ionization chamber obtaining the phenomenon. And right here another crux of the problem arises!

Due to the necessarily limited diameter of the logging instrument lowered into the hole, it is impossible to effect *complete* shielding between the Neutron source and the ionization chamber. Consequently, Neutron/Gamma curves recorded under all competitive methods are affected by this detrimental *primary* Gamma radiation to a greater or lesser extent, *depending upon variations in the size of the bore-hole,* as well as upon other conditions encountered therein. Therefore, and naturally enough, the Neutron/Gamma curve may lack clear definition, and the interpretation of the faulty curve may reflect conditions inconsistent with the true formation facts.

Reasons for PGAC's *Pin Point Accuracy*

Since the exclusive PGAC Slow-Neutron counter is not responsive to Gamma Rays *of any type,* no shielding against them is necessary. And since the PGAC counter is not responsive to Fast-Neutrons either, no shielding is even required against the Fast-Neutrons that may go from the bombardment source directly to the counter. With only those Neutrons which have been slowed down by traversing the formation being detected by the PGAC counter, *the reason* for the clear definition and superiority of our Neutron/Neutron curve becomes obvious.

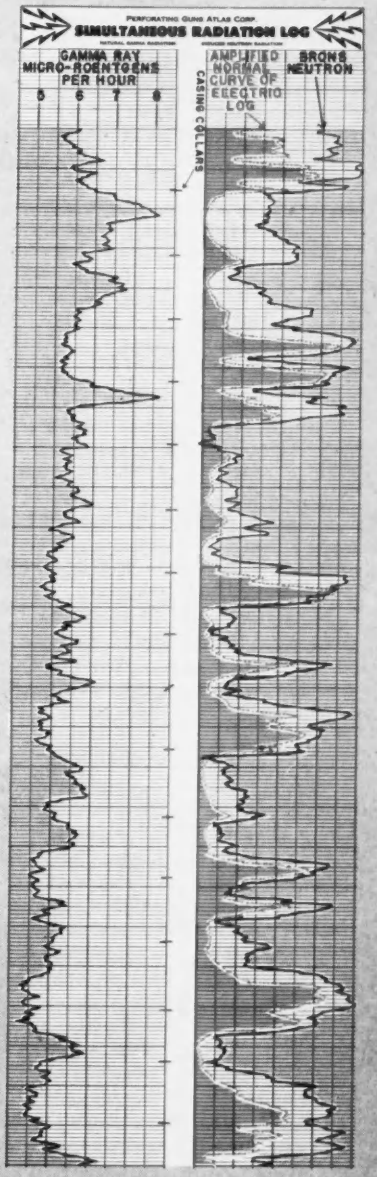
Because of these many exclusive PGAC features, no other radioactivity log can possibly equal PGAC's SIMULTANEOUS RADIATION LOG. And remember too, only the Perforating Guns Atlas Corporation offers this proved superiority in *Accuracy, Stability, Reliability, and Economy.*

So, play it safe . . . always call in PGAC to run a Radiation Log on your well — you'll get a better log, better service — and you'll save 60% of your rig down-time!

PGAC Automatic Correlation – like marriage – Sure Prevents Human Errors!

AUTHENTICATION!

Substantiation of these *behind-the-scenes* facts may be found in the new technical volume, "Principles of Petroleum Geology," by Wm. L. Russell, Associate Professor of Geology at Texas Agricultural & Mechanical College. Any additional data you desire may be obtained without obligation by writing PGAC for answers to your specific questions.



Another example of PGAC's outstanding correlation (of a Neutron/Neutron curve with the electrical log) in an area where, previous to PGAC's Simultaneous Radiation Logging, correlation was very difficult — if not impossible.

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Canadian Affiliate: PERFORATING GUNS OF CANADA, LTD., Edmonton, Alberta, Canada

(c) Dilution factor = $\frac{\$615}{1025 \text{ bbl.} \times 13 \text{ days} \times \$0.30}$ = 15.4 percent

3. Bentonite, caustic, quebracho mud (3453-7500 feet).

(a) Final mud volume cost = 1150 bbl. × \$0.65 =	\$ 748	
(b) Mud volume loss of circulation = 250 bbl. × \$0.65 =	163	
(c) Maintenance cost: 1050 bbl. × 7.6 percent* × 41 × \$0.65 =	2,127	3,038

4. Bentonite, CMC, caustic, quebracho mud (7500-11,436 feet).

(a) Final mud volume cost = (1425 barrels × \$0.85) — (1150 barrels × \$0.65) =	\$ 464	
(b) Mud volume loss of circ. = 1000 barrels × \$0.85 =	850	
(c) Maintenance = \$12,473 — (\$3038 + \$464 + \$850) =	8,121	9,435

(d) Dilution factor = $\frac{\$8121}{1288 \text{ barrels} \times 92 \text{ days} \times \$0.85}$ = 8.1 percent

Loss of Circulation Material	1,334
Total Well Mud Cost	\$15,008

* Assumed same as similar mud type on previous well.

Dilution factors for the various muds on the two wells are summarized as follows:

Mud Type	First Well (Cost—\$6799)	Second Well (Cost—\$15,008)
Salt Water Type	28%	15.4%
Bentonite, caustic, quebracho	7.6%	7.6%*
Bentonite, CMC, caustic, quebracho		8.1%

* Assumed to be same on both wells.

Since the dilution factor while using the salt water type mud on the second well was less than that calculated for a similar mud on the first well, and the dilution factors for the chemically treated bentonite muds were comparable, it would appear that the \$15,008 mud cost for the one well was as reasonable as the \$6799 mud cost on the neighboring well. Of course, higher loss of circulation cost adds to the second well total. Nevertheless, this cost item is identified and accountable.

This comparison also illustrates how "days on mud" influences total mud costs. In the second well, slower penetration rate, due entirely to extremely hard formation drilling, extended the drilling period below 8500 feet. However, the dilution factor below 7500 feet compared favorably with the dilution factor from 3453 feet to 7500 feet, which indicates that low specific gravity solids buildup, requiring water dilution, occurred as a result of drill pipe erosion of shales above the hard formation drilling zone. Aside from the greater loss of circulation cost, this normal maintenance cost over the extended drilling period accounts for the great difference in total mud costs between the two wells.

Cost Appraisal of Weighted Muds

As mentioned earlier, this analysis does not consider weighted muds containing high specific gravity solids (barytes), although the same basic approach, involving final volume cost, miscellaneous cost, maintenance cost and dilution factors could be applied.

As illustrated in this discussion, water dilution is related to addition of low specific gravity formation solids whose principal effect is weight increase. Under these conditions water dilution quantities are usually high while unit mud costs are low when compared with weighted muds. On the other hand, the predominating effect of low specific gravity formation solids addition to weighted muds is an increase in viscosity. Consequently, as more formation solids become a part of the mud, it becomes necessary to reduce the bulk of the solids by dilution with water and to restore the weight and mud characteristics by the addition of barytes and treating chemicals. The same method of adjusting solids concentration must be resorted to if the maximum solids are present in a mud and it becomes necessary to increase the unit weight with barytes. This explains the practice of discarding as much of the native mud as possible and adding water before adding barytes.

As a general rule, water dilution in high weight muds is low when compared with low weight muds where weighting material is not used. This is because water is not added to reduce unit weight and chemical treatment used greatly depresses the yield of all clays that become a part of the mud. However, since the cost of weighting material is involved, unit cost of weighted muds are comparatively high.

Since water dilution required for maintenance of a weighted mud is related to viscosity increase which in turn is associated with the yield of the low specific gravity solids involved, dilution quantities cannot be calculated in the manner presented in this discussion pertaining to low weight muds. Yield of the clay solids depends upon the chemical treatment of the mud. Consequently, water dilution required for viscosity control of the various weighted mud types in use today would have to be determined empirically.

Conclusions

Drilling mud costs are influenced by three principal factors: (1) water dilution, (2) unit mud cost, and (3) days mud used. As drilling proceeds with any controlled water base mud, water is necessarily added for the control of viscosity or unit weight increases created by the "buildup" of low specific gravity formation solids, and each barrel of new mud resulting from the water addition and solid buildup must be treated with the proper agents to condition the barrel of new mud to the specified properties of the rest of the system.

Because of this, mud maintenance cost is the largest single factor influencing or explaining drilling mud costs. By segregating final mud volume costs and miscellaneous costs from a total mud bill, mud maintenance cost can be determined and dilution factors estimated.

Since the amount of water dilution and the cost to condition the volume of new mud formed are so influential, these factors should be recognized and used to analyze, appraise and justify expenditures required to provide mud standards necessary for the successful completion of a drilling project.

Since water dilution is directly allied with buildup from formation solids, it is obvious that improved drilling practice and pit design result in direct mud cost savings. As solid buildup occurs in the mud due to excessive drill pipe erosion, or pit design fails to provide proper settling of fine cuttings, fewer feet of hole may be drilled per barrel of water added, which, when considering the unit cost of the new mud to be prepared, results in a higher mud cost per foot drilled.

Consideration of solid buildup and its relation to water dilution and mud costs should be limited to any detrimental effect it may have on mud properties such as viscosity, weight, gel strength, filtration, or filter cake characteristics.

Such a cost analysis approach may be used to explain a particular total mud cost by identifying the influencing cost factors. Mud costs are related to mud standards. Examination of the various cost factors, rather than a comparison of total cost or cost per foot will provide a more realistic and understandable accounting of mud costs.

(Last of Two Parts)

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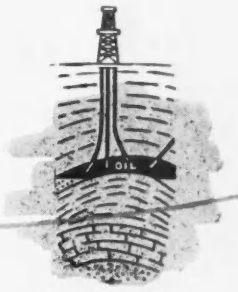

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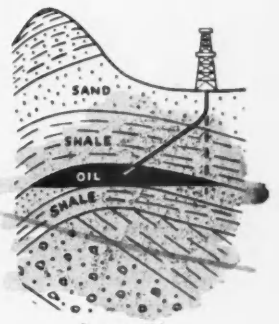
Eastman Directional Drilling was first used to explore productive zones off the California Coast by drilling wells from shore to subsea formations. Since that time many new applications of DIRECTIONAL DRILLING have been made by competent Eastman engineers to the extent that Directional Drilling now is utilized extensively and applied successfully in the following manner: EXPLORING geological structures by drilling multiple wells from single locations; EXPLOITING new oil reservoirs; DEFLECTING the course of the well to reach otherwise inaccessible bottom locations; SIDETRACKING obstructions and STRAIGHTENING the hole; REDRILLING old wells profitably; and CONTROLLING wild wells.



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Eastman engineers prepare carefully planned proposals in advance of the actual directional drilling work that is to be undertaken by the operator. These engineering suggestions are based upon vast experience in all major oil fields.

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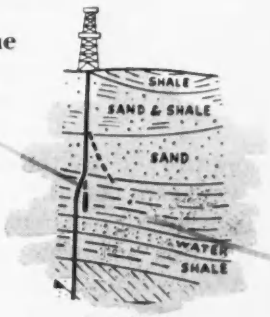
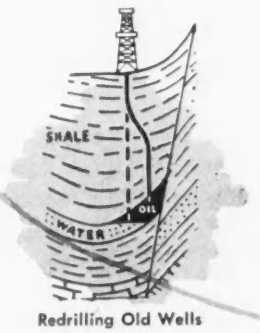
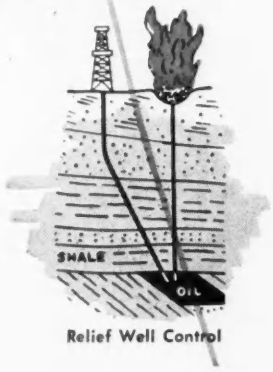


Straightening and Sidetracking



Redrilling Old Wells Profitably



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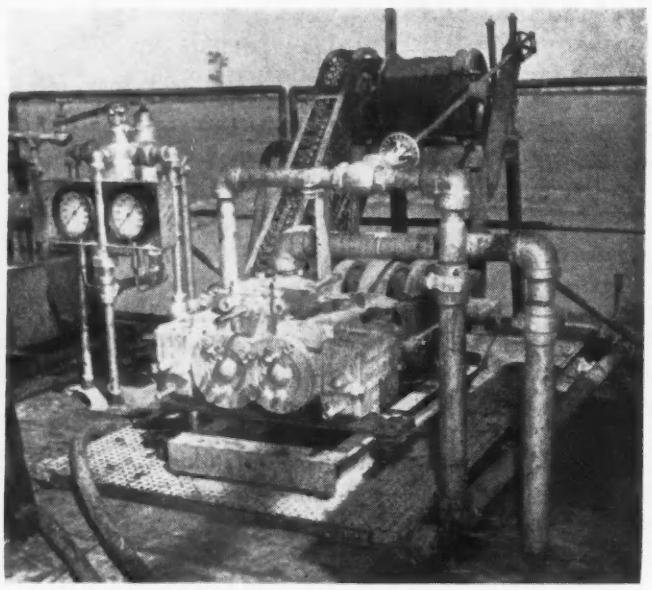
HOW TO—Speed Running Wire Line Tools in Well



Make-shift, temporary rigging for wire line reels satisfies requirements for shallow well work; however, heavy duty, deep drilling rigs should be equipped with more permanent, shaft or V-belt driven spools similar to the one illustrated. The device will speed running wire line tools; the reel will rest on a more secure base; operation of the unit will be smooth and more accurate; and the possibility of the rotating reel's dropping from a temporary support will be virtually eliminated.

Materials employed in the belt driven unit represents junk and remnant equipment. All requirements for pipe, angle iron and plate steel include short or welded segments; hence, completion of the unit will not require an investment in long, heavy and expensive components.

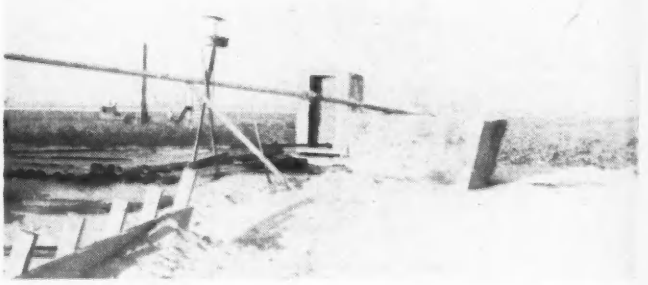
The skid base is six-inch I-beam divided at each end with 4½ drill pipe spreaders. Each end of the spreader is capped with welded steel plates to block entrance of mud or foreign objects conducive to corrosion. Two I-beam, skid-size, diagonal braces are installed beneath the steel plate floor to afford necessary support for the engine, reel stand and reel. The base is an all-welded structure.

A base for the engine consists of four-inch I-beam skids connected at each end with four-inch angle iron spreaders. The engine is anchored to the skid base by means of bolt type clamps attached to two ⅜x4-inch metal straps welded to the engine bed. These adjustable clamps permit proper alignment of the engine pulley, V-belts and reel pulley.

The size of the steam engine employed will depend entirely upon the drilling assignments involved. Actually, the illustrated engine is capable of maneuvering wire line tools to great depths with comparative ease; however, either a larger, or preferably a smaller, engine will perform the job satisfactorily.

The wire line reel is atop a welded, two-inch angle iron rack immediately behind the steam engine. The adjustable base of the reel has been left intact to facilitate tightening or loosening the V-belt drive. A three-inch strap iron support extends from the reel stand to guide a rod remotely operating the throttle valve on the steam engine.

HOW TO—Avoid Damage to Crops



Restricting the oil or salt water from a drilling well is essential in agricultural areas to protect crops. The spray or flow can be diverted to a tank large enough to contain the water cushion and the oil recovered by the drill stem test.

A tank similar to a mud pump suction pit is installed near the access road where vacuum trucks can pick up the fluid for disposal, if the discard is to be removed from the immediate area.

Fluid passing through the tester and the drill stem is carried by a lead line from derrick floor to tank.

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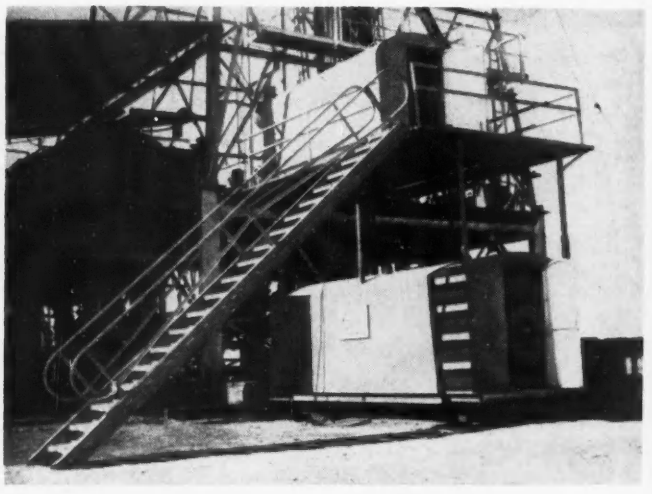
HOW TO—Unitize Rig Tool Houses



Telescoping supports extending below an elevated tool house will speed rigging time and provide a neater and more secure unit. Generally, the floor level tool house rests on make-shift timber or independent pipe structures which must be transported as independent units. In many cases, the support frames are tailor made for each location. The process is either time consuming or, in the case of independent structures, load requirements are increased enroute from location to location.

A practical idea is to telescope the elevated house supports into a lower tool house. The size of the vertical supports depends entirely upon the weight of the house and its possible content, the only requirement being the selection of pipe which will form slides for the telescoping mechanism.

Initial construction stages of the installation consist of cutting six holes in the roof to accept the telescoping supports. The holes should be positioned so that the housing unit base will drop to a point immediately above the main skid runners. Once the holes are cut in the roof and the housing units are reduced to the desired length and lowered into the house, the welder anchors the units to the face plate of the skid runners. The housing units can be given additional support by extending angle iron braces to the frame of the house. Completion of the housing units consists of burning holes near the top to accommodate one-inch anchor pins.

The floor level house is bolted to a steel plate covered frame formed of two-inch pipe welded with adequate cross bracing for reinforcement. The dimension of this frame should not extend beyond the edge of the elevated house since the sidewalks are hinged to fold for transport, thus reducing the platform width to within road limits.

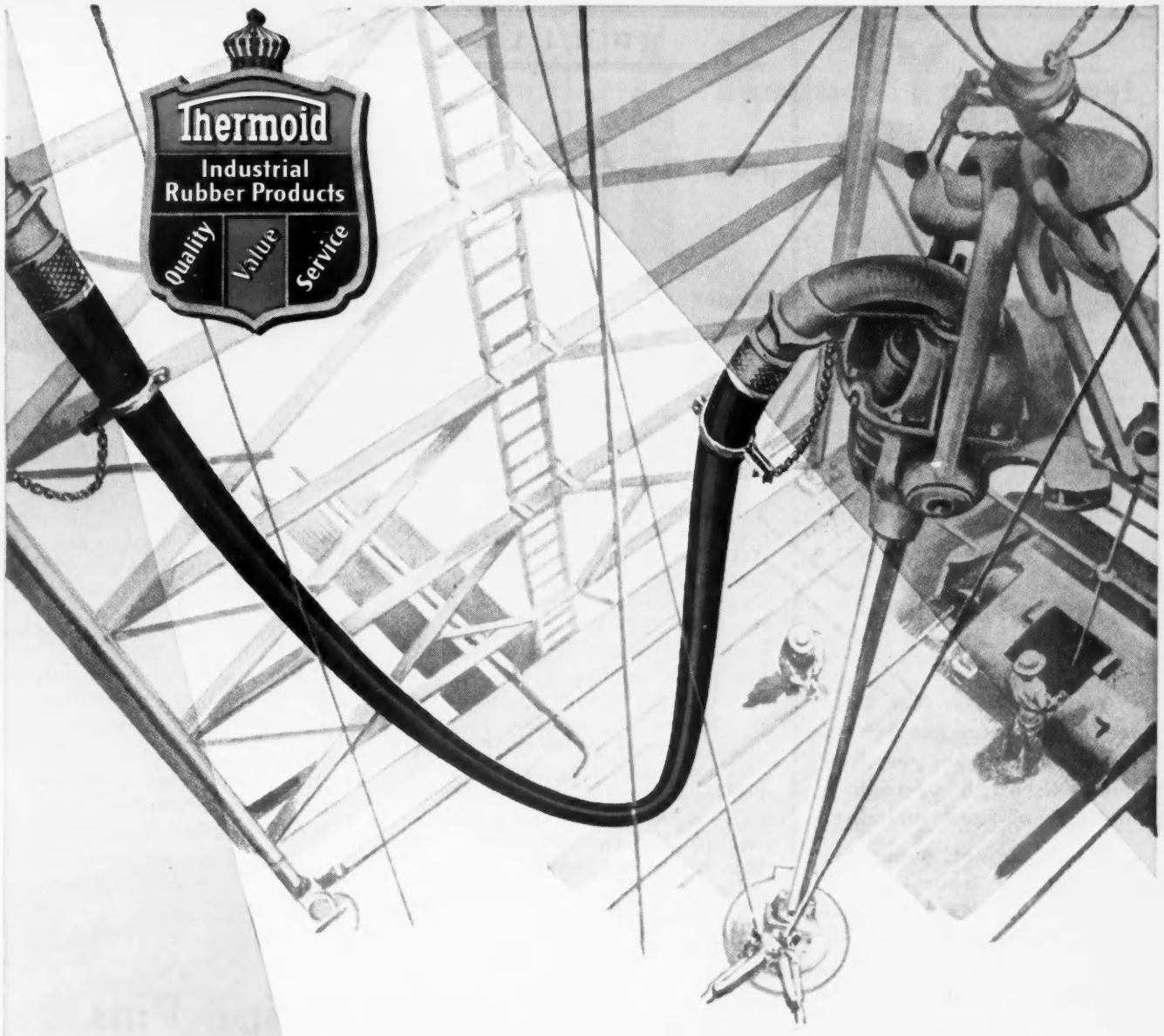
Once the main platform is completed, pin hinges are tack welded to the side of the frame for the support of the pipe frame, sheet steel sidewalks. The width of the sidewalks can be gauged to predicted needs.

Following completion of the platform and hinged sidewalk members, pipe extensions, which will slide into the housing unit, are cut to a length permitting elevation of the house to floor level. The extension legs are perforated at a point to adopt the one-inch anchor pins which will extend through the sides of the housing unit.

Completion of the unit includes welding the extension supports to the frame of the tool house platform. Strap steel supports are then pin hinged to the outer frame of the sidewalks and connected to the extension legs with a slot and hook device. Two ports are cut in the floor plate to fix the strap iron hooks attached to the stairway.

Guard rails around the walkways are musts since the unit is elevated to floor level. The rails can be made of pipe or angle iron and connected to the sidewalk with sleeve adapters.

Rigging the duplex toolhouses begins with spotting the lower unit near the substructure. Before placing the guard rails, the upper house is lifted to the platform, properly aligned and bolted. At this point the platform and house are lifted to floor level with a wire derrick line. When the unit reaches the desired level, the telescoping legs are pinned into position. Then, the hinged walkways are lifted, guard rails installed and the stairway raised to its assigned position.



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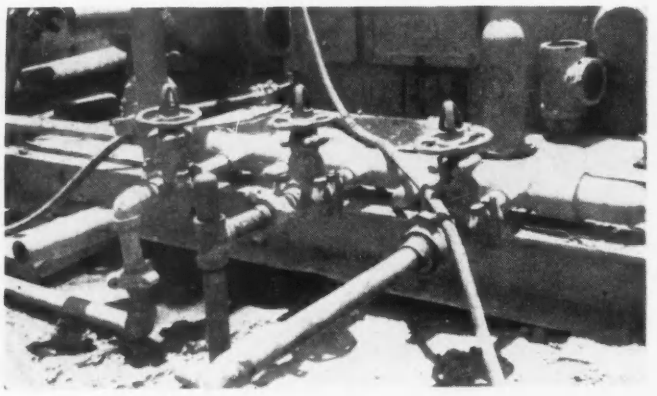

A manifold connected to the rig standby pump will increase the utility of the entire mud system. Often the operator assigns the standby pump the responsibility of mixing mud, gunning pits and transfering water; however, in many instances inadequate provisions are made for the rapid switch from one duty to another. To compensate for this situation, an operator designed a manifold log which flanges to the discharge line and anchors to the skid base of the standby pump.

The body of the manifold consists of a four-inch hydraulic nipple four feet long. A plain and a bull plugged collar is attached on each end of the manifold. Five two-inch hydraulic collars are welded an equal distance apart along side the manifold unit.

In field service, the manifold from the standby pump can be attached to the mud guns, pit jets, blowout preventers or the master pump suction. Since the gate valves are stationed at each opening, any of the foregoing operations can be completed without interrupting operation of the pump.

The illustrated manifold rests in a metal saddle formed of line pipe. Spot welding has been used to secure both the manifold and support to the mud pump skid.

HOW TO—Protect Drill Pipe Pins

Drill pipe pins will be given added protection if the timber rack is covered with alternate strands of cat and drilling line. The installation will provide a cushioned, yet reinforced surface, that will withstand the weight of the pipe, permit thorough washing of the pins and protect the precision-formed base from serious damage.

Deep hole drilling generally requires frequent trips to change bits and bottom hole tools. The conventional timber pipe rack does afford certain protection to the tool joint pin; however, extensive use results in the gouging of holes and recesses in the supporting surface. Although the condition is not serious, the gouged recesses tend to accumulate mud, abrasives and water. Under the circumstances, it is near impossible to maintain the tool joint pin perfectly clean at all times.

In an effort to provide a rugged, non-sagging rack, an operator cut segments of drill and cat line to be nailed onto the timber rack. The manila rope is anchored by nails driven through spread strands, and the wire rope is retained by spikes driven into the timber and bent over the line.

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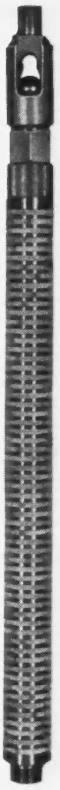

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S & R Steel Mud Pits are skidded on 6″ H-Beams, with heavy cross-braces along the length. Skids are 8 feet wide and 33 feet long; the pits may be hauled on any standard oil field trailer. Beams are recessed at each end, so that the winch line may be snubbed or wrapped around the ends of the braces for speed, safety and convenience in loading and unloading.

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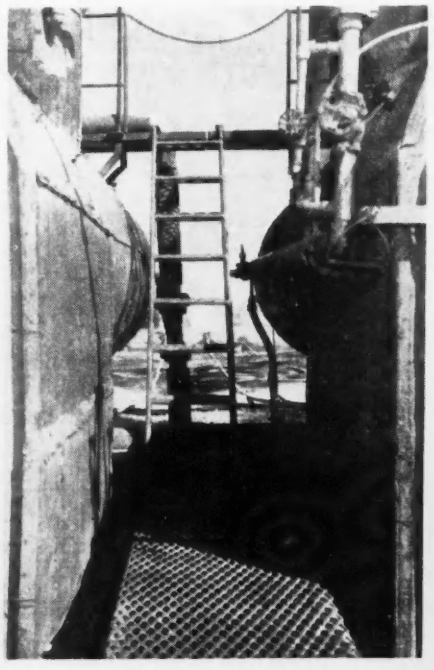
HOW TO—Increase Safety Conditions Around Boilers

Access to the top of boiler barrels is normally provided by means of makeshift, unsteady ladders, the net result being a working condition hazardous to crewmen. To overcome this situation, one operator constructed atop the boiler barrel a permanent, guarded walkway, with removable steps leading up to the walk between each boiler. Fabricated of scrap metal, the low installation expense of the stair and walkway primarily involved labor charges.

The framework for the walkway is

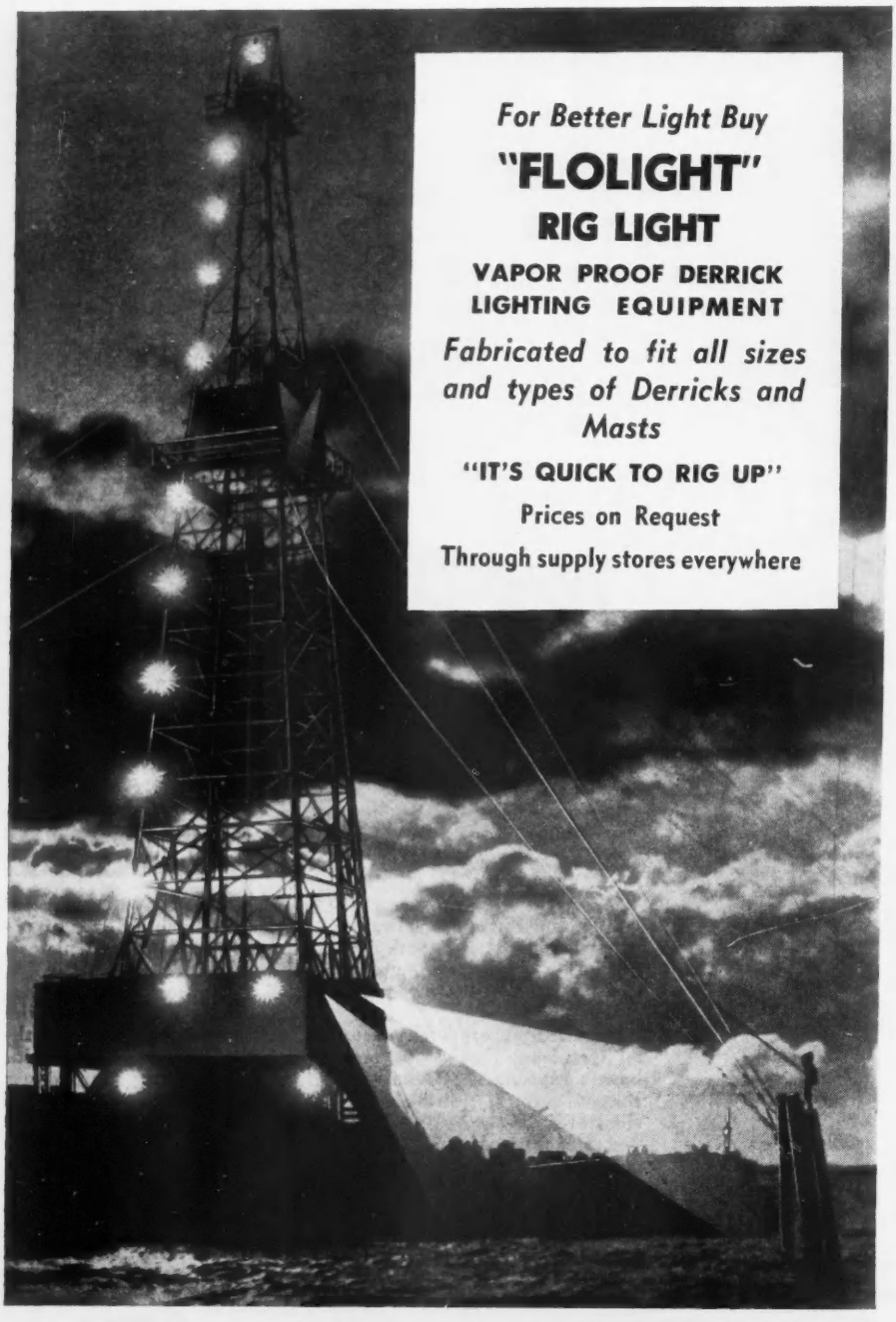


constructed of 1½-inch angle iron cross-braced at frequent intervals to insure complete rigidity. An expanded metal walking surface is provided to reduce the hazard of personnel slipping while working above boiler level. The walkway frame is anchored to the barrel plate by means of welded, angle iron supports. Collapsible guard rails are bolted in place alongside the walkway frame. Chain linkage guards the gap between each boiler.

The stairway is formed of one-inch pipe and each step is covered with heavy gauge, non-slip expanded metal. Sleeve adapters rest alongside the walkway to anchor the ladder in position. To complete the walkway system, elevated two-inch frames, covered with expanded metal, are placed on the ground at the side and in front of each boiler.

For rig transport, the boiler barrel walkways remain in position. Each guard rail is collapsed and the guard chain, blocking the gap between each boiler, is removed. Dropping the stairway simply involves disengaging the sleeve adapter.

Although the expense of the illustrated installation exceeds the cost of a makeshift ladder and walkway, the added safety features will reduce the potential accident frequency and soon amortize the equipment investment.



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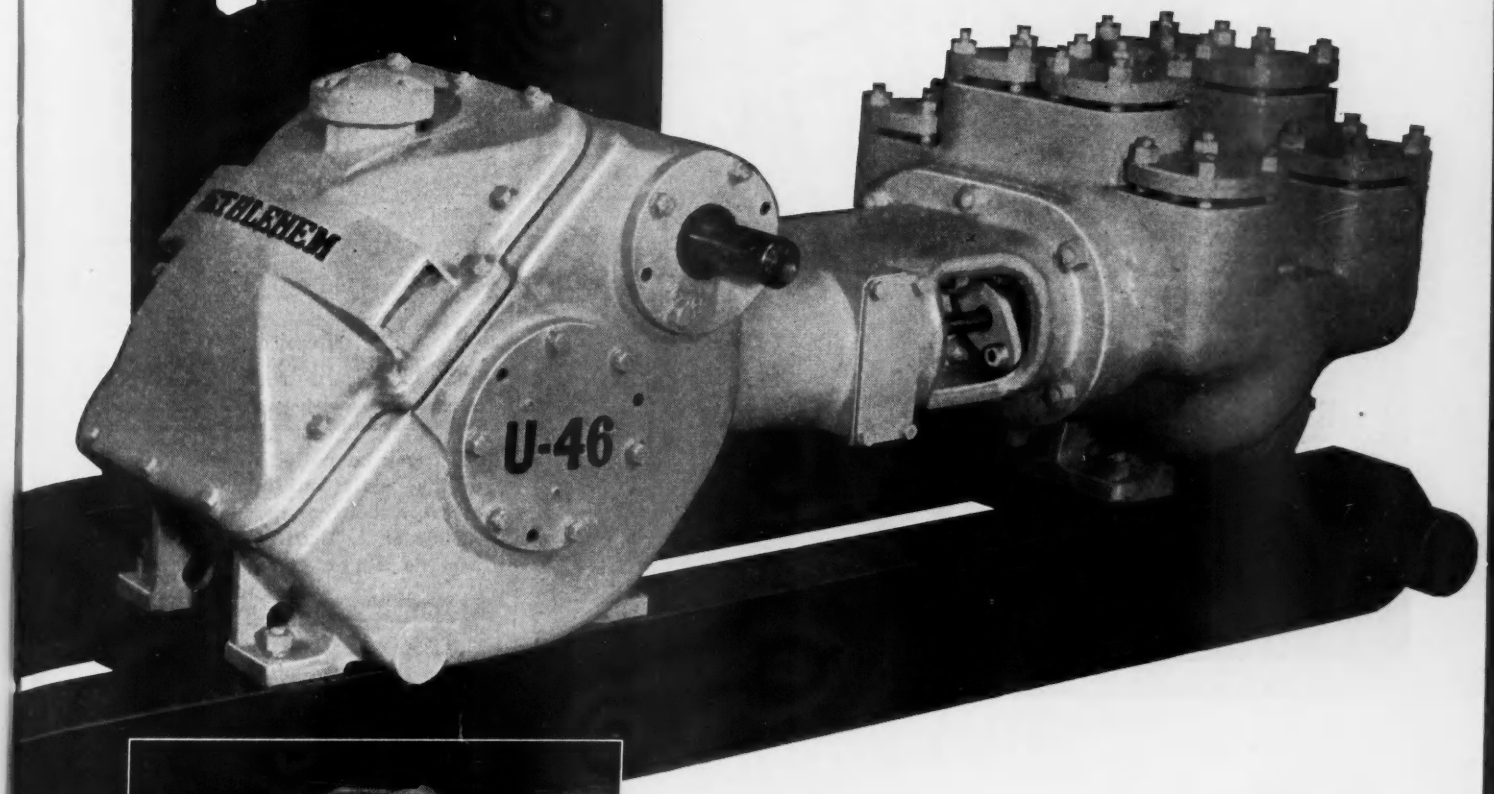

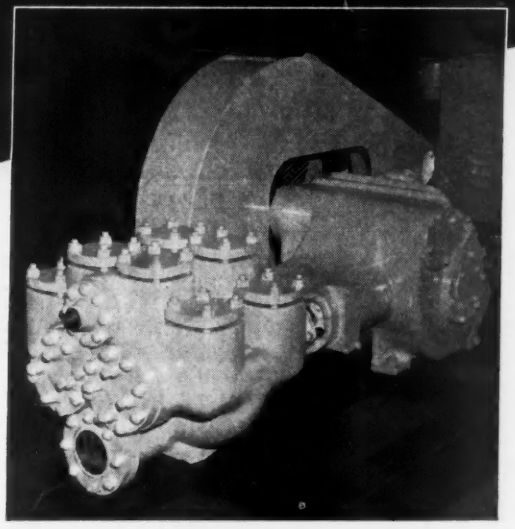

The Bethlehem U-46 is a fine new utility pump that will stay busy on anybody's rig. Frankly, we don't think there's a better unit built for its particular class of work.

The U-46 is a horizontal, duplex, double-acting pump with 4-in. bore and 6-in. stroke. Its primary duty is fresh-water pumping around the rig—getting up the water for mixing, brake-cooling, rig wash-downs, etc. But its fluid end can be equipped to handle oil and mud as well; salt water too, whenever you have a disposal job around a lease.

Speaking of leases, the U-46 is a wonderful performer on gathering work. And there are plenty of other spots where it can pinch-hit on short notice. Mighty handy fellow to have around!

This completely portable unit can be furnished with any type of prime mover—electric motor, gas, gasoline, or diesel engine. Full details and specifications are available through our nearest sales office.

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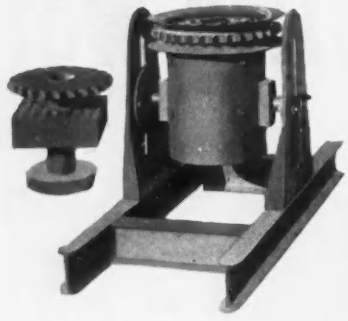
BETHLEHEM STEEL

HERE'S A RATHOLE DIGGER



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It's actually a tilting, "baby" rotary, skid mounted and driven through the regular rotary table . . . and it gets those ratholes down in less time than it takes to jack up and re-set the big table. Available in three sizes, for digging ratholes up to 13" O.D., BEMCO Rathole Diggers are fully portable, easily moved from one rig to another. Regular square or fluted kelly's are used, with drive bushings furnished to specifications.

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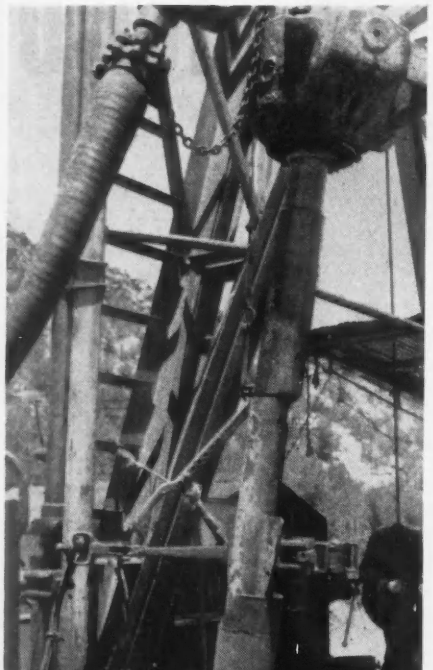

HOW TO—

Protect Small Kelly In Large Rathole

An equipment care practice being adopted by an increasing number of operators is that of protecting the smaller kelly from unnecessary bending or kinking when it is lowered into the large diameter rathole.

To prevent such injury, a scabbard of smaller diameter pipe than that in the large rathole is prepared. This unit has a pair of ears that permit its being set down inside the original rathole and rest at the top in the manner shown. In the case illustrated, the original rathole is of 9⅝-inch pipe, designed for 3½- or 4½-inch and larger kellys. The scabbard, which is sufficiently long to allow the smaller kelly to hang suspended inside it, is of six-inch pipe and is designed to accommodate three-inch and smaller kellys. Such a scabbard is a practical method of protecting the kelly not only while it is in the rathole, but when it is being transported between locations.

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Ram plunger and is drawn in a straight, torque-free pull through Ram. Ram is its own back up! Less rigging time—more effective power!
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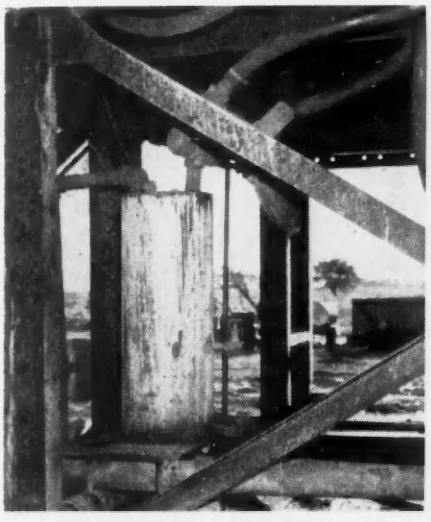

HOW TO—
Scrub Fuel Gas For Use on Power Rig

Power rig operators will be benefited by more efficient engine performance and extended engine service life through the installation of a simple, compact fuel scrubbing system. The illustrated unit, being permanently attached to the substructure, is not removed during rig transport.

Constructed of a segment of 12-inch casing, the scrubber barrel is sealed at either end with quarter-inch plate metal. The cap segment is flush with the outside diameter of the chamber while the base plate extends at each end to support the tank. The upper plate is fitted with two 2-inch and one 1½-inch collars weld-sealed into position. The collar transporting fuel into the scrub chamber is fitted with a riser extending to a point near the base plate. This arrangement guides the fuel gas to the lower section of the chamber so that it bubbles up through a caustic solution for scrubbing.

A one-inch drain cock is welded into the side of the tank near the base while a fluid level valve is stationed 18 inches above the base plate. Permanent anchorage to the structure beams is assured by plate metal extension legs elevating the tank to a point above the standpipe line.

The 1½-inch cap plug atop the tank is removed to recharge the unit. Since the rig is powered by engines requiring varied injection pressures, a duel discharge line is attached to the system. It will be noted that one of the discharge lines carries a regulator to deliver low pressure fuel to the smaller engine.

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THE NEW, LARGER, STRONGER, 12" WECO TONG LINE BLOCK

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- FORGED STEEL SWIVEL EYE.
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The Block is constructed extra heavy throughout. The sides are heavy steel plate and the sheave is malleable iron with webb design to minimize total block weight without sacrificing strength. Of course, it has the WECO patented drop side feature which makes it possible to string or unstring the block without using the end of the line.

Actual tests with loads many times greater than working loads assure an ample safety factor. Ask your WECO representative for complete details and advantages of the new 12" Tong Line Block.

The 8" WECO Tong Line Block, with "Oilite" bearing is available for handling ordinary size tongs, wire line guides and for many other applications.

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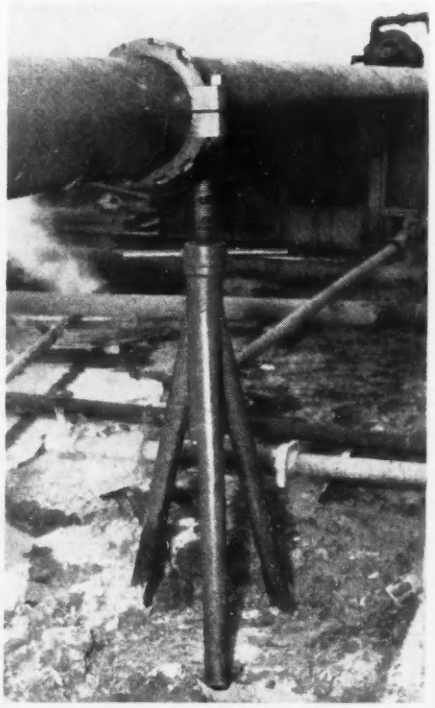
HOW TO—Use Portable Stand to Align Mud Line

Rig-up efficiency will be increased if portable flow line supports are employed on location. Built of discarded parts, this simple stand will insure the secure support and proper alignment of the mud flow line.

The basic part of the support consists of a screw element taken from an old jack, liner puller or similar equipment. The companion guide of the screw is salvaged and cut to an approximate thickness of two inches. Three-eighth-inch lug type handles are welded to the collar to permit ease in adjusting to the desired height. A plate metal saddle on the top part of the screw is shaped to conform with the under side of the pipe flow line. This screw type leveling device is a major part of the project.



The case for the adjusting device is a one-foot nipple of 2½ or 3-inch tubing with a ring welded around the top. If desired, a pipe sleeve of smaller diameter can be slipped into the case to guide the lower section of the screw.

Two-inch pipe legs are angle welded alongside the screw case. The base plate, which aligns the legs and distributes the weight of the flow line, consists of three-eighth-inch sheet steel.

Adjustment of the support simply involves lifting the flow line, leveling the screw to the desired height and locking the retainer collar against the case. Although the initial investment involved is more than the expense of makeshift block supports, the unit soon pays out by increased rig-up efficiency and secure support of the flow line. Advantages of the support will be better realized in the event a well starts kicking and secure anchorage of the flow line is of basic importance.

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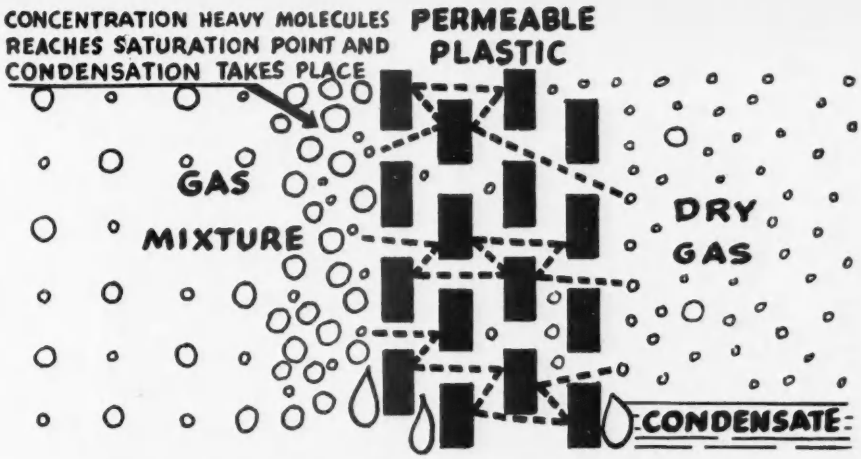

FIGURE 1. Schematic diagram showing how the permeable plastic separates gases by diffusion or atmolysis, utilizing different molecular velocities to obtain concentration of heavy molecules upstream from the porous barrier.

Fluid Separation With Permeable Plastics

By C. B. JAHN
Petroleum Engineering & Tool Company, Houston
and
DONALD M. TAYLOR
WORLD OIL Staff

AMONG OUTSTANDING recent developments in the field of plastics is a highly permeable element that has proven satisfactory fluid separation medium. Although field and laboratory tests are constantly under way to further explore new applications of this material, much can be told now of its development, characteristics and some results obtained. A theoretical analysis of the principles employed are briefly presented to introduce the reader into this new field of fluid separation.

THE newest and perhaps the most promising development in the field of oil and gas production is a permeable plastic element which has proved extremely efficient in the separation of fluids. Not only is it capable of removing moisture from hydrocarbon gases, but it also separates water from distillates and crude oil. In tests verified by careful laboratory experiments, the new medium, when used as a core in separators, has removed water vapor from a high-pressure gas stream without measurable changes in temperature. It has proved capable of depressing the dew point of a gas from 5° to 20° F. (depending upon the rate of gas flow through the unit and upon the type of element). And, it has been able to break certain types of water-in-crude or distillate emulsions. Startling as these results may appear, they are being duplicated every day by actual full-scale field installations.

Characteristics of Permeable Plastic

This permeable plastic material, which resembles orange-colored taffy candy in appearance, was discovered when a research chemist mixed fluid plastic with certain other substances and obtained a solidified plastic whose surface consisted of a myriad of small pores. These pores are interconnected to produce a material of high and variable permeability. Further research proved that the size of the pores and the texture of the plastic could be controlled by varying the additive compounds while the plastic

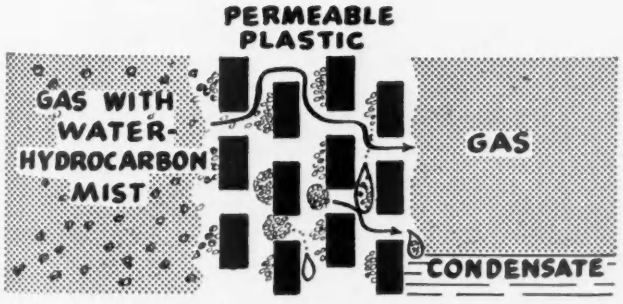

FIGURE 2. Schematic diagram showing how the permeable plastic extracts free water and hydrocarbons from gas stream, utilizing multi-direction changes.

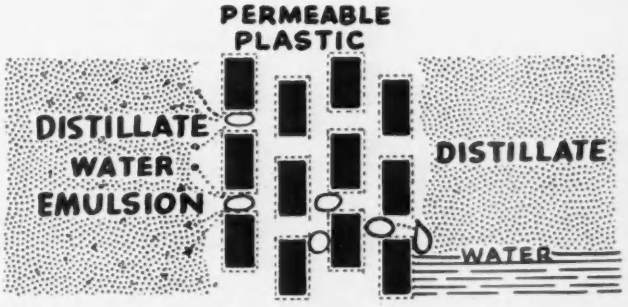

FIGURE 3. Plastic separates water-in-hydrocarbon emulsions by coalescing action, based on the principle that two immiscible fluids cannot take possession of a surface at the same time.

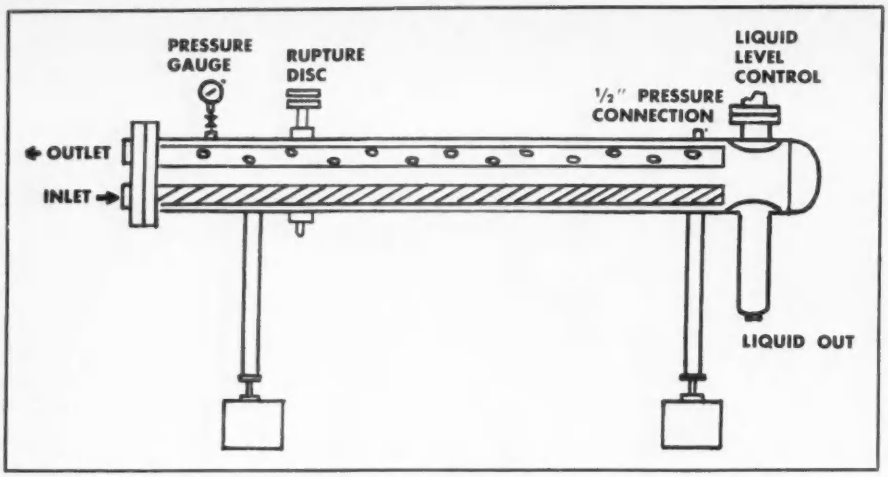

FIGURE 4. Construction of plastic core separators.

base material was in a fluid state. Permeability of the material can be varied in this manner from 10,000 to 50,000 millidarcys. Pore size can be varied from 5 to 50 microns.

How It Works

How does the permeable plastic medium separate distillates and water from gas and break water-in-distillate or crude emulsions? The phenomenon is an involved process, theoretically, and is based primarily on three principles:

- 1. Separation by diffusion, known technically as atmolysis.
- 2. Mist extraction by changing direction of fluid flow rapidly and many, many times.
- 3. By coalescing or gathering molecules of similar liquids to form droplets that, due to their gravity differences, settle out.

The principle affecting water-hydrocarbon separation by means of a permeable filtering or coalescing medium is not new. Two immiscible fluids of different surface tension cannot take possession of a surface at the same time. If an emulsion of two immiscible fluids is passed through a permeable barrier, the fluid in possession of the surface of the barrier will traverse it with ease, while the other liquid will tend to be repelled and concentrated.

Plastic Ideal Medium

Since the phenolic resin which composes the permeable plastic lends itself to permanent hydrocarbon wetting, even to the extent that hydrocarbons will replace water on the surface of the plastic material, it is an excellent medium through which a water-in-distillate or oil emulsion may be broken. When a water-in-hydrocarbon emulsion flows through the permeable plastic element, surface tension causes hydrocarbons to flow more freely and thereby desert the water which encounters greater difficulty in traversing the small interconnecting channels. Fine particles of water colnect on the upstream face of the plastic and the minute passages become clogged. When this condition becomes widespread throughout the plastic element, back pressure forces droplets of water blocking the passages to form larger drops on the down stream face of the permeable material. These drops fall by gravity to the bottom of the vessel where they may be drained out.

Because it takes a greater pressure to force water through the hydrocarbon-wet plastic than it does for any of the hydrocarbons, none of the water passes through the channels until sufficient back pressure has built up. Thus, little or no water passes through until a large part of the plastic has been blocked by water particles. This characteristic accounts for the pulsating effect noted in emulsion breaking.

Separation by Diffusion or Atmolysis

Prior to World War II, the principle of separation by diffusion or atmolysis was little used and almost forgotten. The famed Smyth Report on the development of atomic energy

FIGURE 5. Test of separating unit in an East Texas oil field. One and one-half million cubic feet of saturated gas at 1800 pounds per square inch, 90° F. enters unit from line at left. After passing through the plastic with no measurable drop in temperature, the dew point is depressed to 47° F.

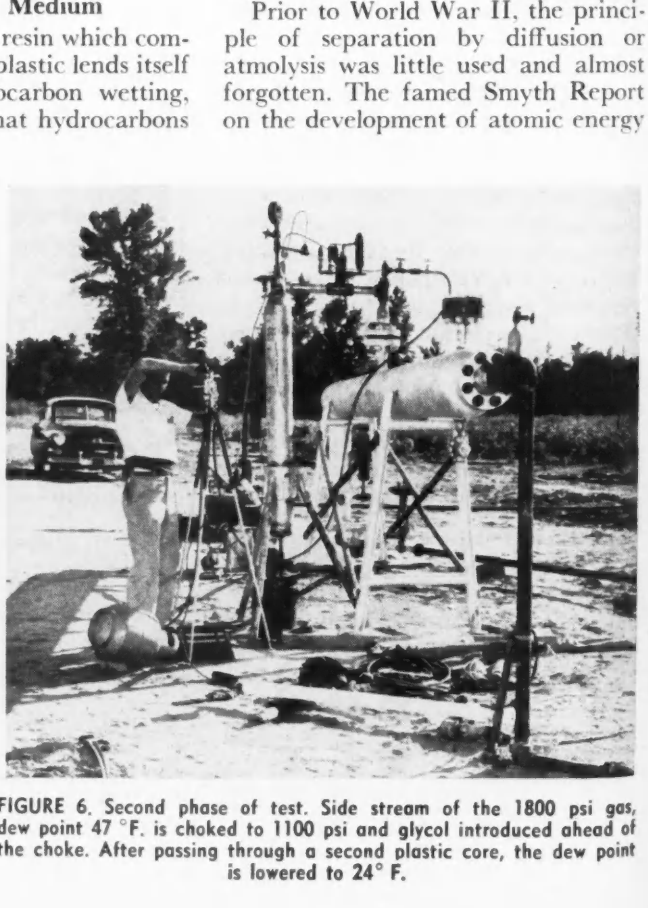

FIGURE 6. Second phase of test. Side stream of the 1800 psi gas, dew point 47 °F. is choked to 1100 psi and glycol introduced ahead of the choke. After passing through a second plastic core, the dew point is lowered to 24° F.

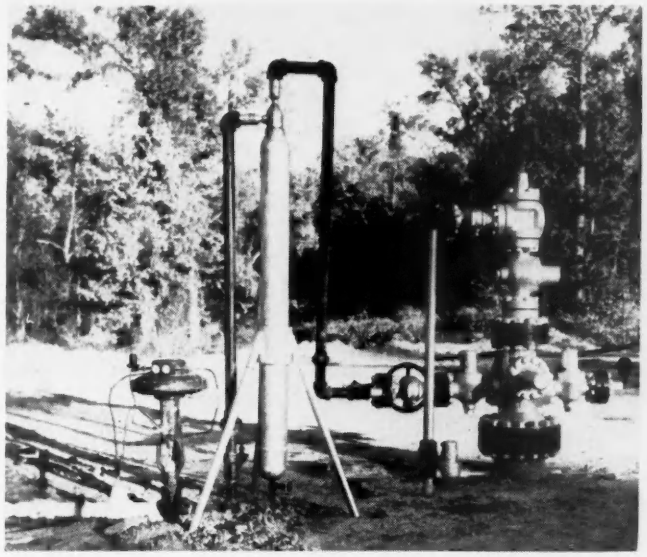

FIGURE 7. Test unit on a gas distillate well. After passing through the permeable plastic, the gas is choked before entering gathering line. No freezing is experienced despite low ambient temperatures. Note frost on gas line at lower left.

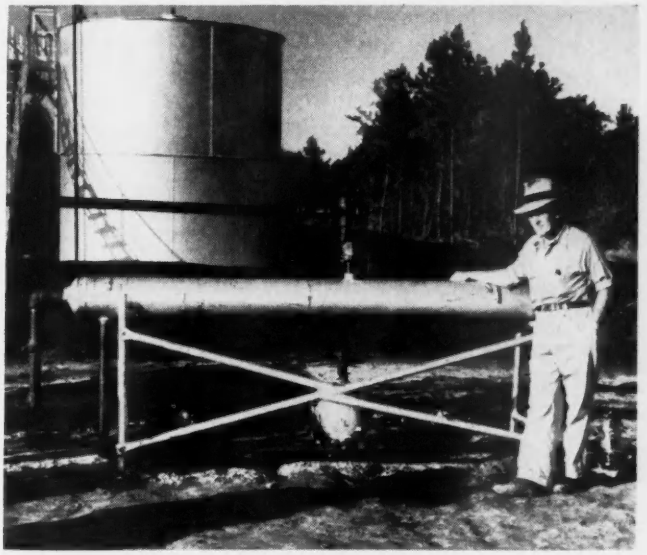

FIGURE 8. Two wells flowing 200 Mcf of gas and 300 barrels of oil with 4 percent basic sediment and water passes through small separator with a plastic core. Gas flowing from the top of separator is dry enough to prevent ice blocks. Oil flowing to tanks contains less than 0.6 percent bs&w.

revealed that this principle was one of the successful methods used to solve the knotty problem of separating Uranium (235) hexafluoride gas from Uranium (238) hexafluoride gas.

The principle involved follows the kinetic theory of gases. In a mixture of gases, the lighter molecules travel faster and collide more frequently with one another and with the walls of the vessel than do the molecules of heavier gases. The velocities of individual molecules vary inversely as the square root of their densities. Thus, if a mixture of gases encounters a porous barrier of very small diameter openings, the lighter molecules will penetrate the barrier more readily, leaving a concentration of heavy molecules on the upstream side of the barrier.

An example will further explain this theory. In a mixture of methane and hexane gases, at atmospheric temperature, methane molecules travel at an average root mean velocity of about 2000 feet per second. Hexane travels at an average root mean velocity of about 900 feet per second. From these data, it can be seen that when a mixture of methane and hexane is confronted with a multitude of minute openings in a permeable plastic medium, more of the faster moving methane molecules will traverse these small channels, following the laws of statistical probability, and leave a concentration of hexane molecules on the upstream side of the permeable plastic element. When the concentration of hexane molecules reaches a saturation point, the vapor condenses and drops out of the stream.

This principle is illustrated hypothetically in Figure 1. A mixture of two different gases is shown on the left side of the permeable plastic barrier, indicated by the staggered black bars. The heavier gas is represented by the larger circles while the lighter and faster gas is indicated by the small circles. The dotted lines show the possible paths which a gas may take to traverse the permeable plastic barrier. Since the lighter gas travels much faster, thereby covering greater distances than the heavier gas, the light gas has a better chance of finding those paths which permit the molecules to pass through the element. As the lighter molecules leave the mixture, there exists a greater concentration of heavier molecules, until this concentration reaches a saturation point and droplets are formed. As the droplets grow in size, they fall to the bottom of the containing vessel where they may be removed.

Mist Extraction

Mist extraction involves removing free water entrained as extremely fine particles in a hydrocarbon gas. In the foreegoing paragraphs, the separation of two gases was discussed, where the heavier gas was separated as a liquid from the lighter fractions. The presence of hydrates in gas has long been a troublesome problem in the production of relatively high-pressure gas. The principle of scrubbing out or removing these fine water particles or mist from a gas stream is somewhat similar to that of separating a light gas from a heavier one, although the difference is sufficient to warrant a clear explanation.

The numerous interconnected openings in the plastic provide a tortuous path for any fluid. Because of inertia, mist droplets have more difficulty than gas in executing the many changes in direction offered by the passages. The droplets tend to be deposited in the plastic. The small droplets combine to form larger and larger droplets until back pressure of the flowing gas forces them through the plastic barrier where they fall to bottom of the vessel.

Seemingly, liquid forms and traverses the plastic in rhythmic surges. Explanation of this action is that the mist collects and progressively blocks the minute passages through the plactic element. When a sufficient number of passages are blocked, the pressure differential across the entire plastic becomes great enough to force virtually all the newly-formed liquid through the plastic walls.

This process accounts for the largest volume of liquid separated from a wet gas stream passing through such a permeable plastic medium. Primary advantage of the plastic as a mist extractor lies in the large number of direction changes presented to any fluid passing through it.

Figure 2 is a hypothetical illustration of what happens in the process of mist extraction from a gas stream when that stream is passed through a permeable plastic medium. The element is again shown by staggered black bars. The mixture of gas and water-hydrocarbon mist is shown on the left of the element; the mist is in-

dicated by the minute circles and the gas is represented by the black dots. The gas is capable of traversing the multi-channel plastic element with greater ease than the heavier, more sluggish mist which accumulates on the upstream side of the barriers. When sufficient mist has gathered, a droplet is formed, and, due to a differential pressure existing across the element, the droplet is forced through it. This process generally takes place throughout the element and a surge in pressure is noted across the barrier when this occurs.

Coalescing

In the case of separating water from a liquid hydrocarbon such as distillate, the principle is somewhat different when the permeable plastic medium is employed. As mentioned previously, two immiscible liquids of different surface tension cannot take possession of a surface at the same time. If an emulsion of two immiscible liquids is passed through a permeable barrier, the fluid in possession of the surface of the connecting channels will traverse it with greater ease, while the remaining liquid will tend to be repelled and thereby concentrated at the minute openings.

Since the phenolic resin of the permeable plastic lends itself more readily to permanent hydrocarbon wetting, even to the extent that hydrocarbons will replace water on the surface of the plastic, it is ideal for breaking many water-in-hydrocarbon emulsions. When such a mixture flows through the permeable material, the attraction of the hydrocarbons to the walls of the plastic medium and the difference in surface tension cause the hydrocarbons to flow through the plastic with greater ease than water. The latter encounters greater difficulty in penetrating the minute channels and is therefore concentrated in droplets on the upstream face of the plastic.

When this condition becomes widespread throughout the element, back pressure which makes the flow possible forces the droplets of water through the plastic where they coalesce in larger volumes on the downstream side. Here, each liquid in its relative uncontaminated state, separates according to their differences in densities. This action accounts for the pulsating effect noted in emulsion breaking. Figure 3 illustrates graphically what happens. The dotted lines surrounding the staggered black bars (the plastic barrier) represents the hydrocarbon-wet surface, while the large ovals show how the water accumulates. In this case, distillate is shown by the small black dots.

An example of the coalescing action of the permeable plastic medium was demonstrated when the distillate from horizontal separators on one lease could not be recombined with the gas stream for transmission through a pipe line to a nearby gasoline plant because water in the distillate caused ice plugs to form in cold weather. Water was removed from the distillate by passing it through the permeable plastic element where the water coalesced and dropped out.

Construction of Equipment

The plastic elements described have been made up for testing and for actual field operations in the form of open cylinders of various diameters and wall thicknesses. Permeabilities of these cylinders can be varied to suit the application for which they are intended. Figure 4 illustrates one application of these elements. The plastic cylinder has been inserted into a cylindrical pressure vessel that was then closed on each end. Provisions were made for an inlet and an outlet for the fluid stream which had to pass through the walls of the plastic material. A liquid collection chamber was added to the bottom where, due to gravity, liquids collected and could be dumped as desired. Normally, a liquid level control provided automatic dumping when the liquid rose to a predetermined level in the collection chamber. A rupture disc was added as a safety precaution, and a means for determining the pressure in the vessel was also provided. The inlet pressure was the upstream pressure; while the pressure inside the vessel was the downstream pressure of the plastic element. Several test units have been made and mounted vertically for ease in construction and in handling. Some of these units are shown in the photographs.

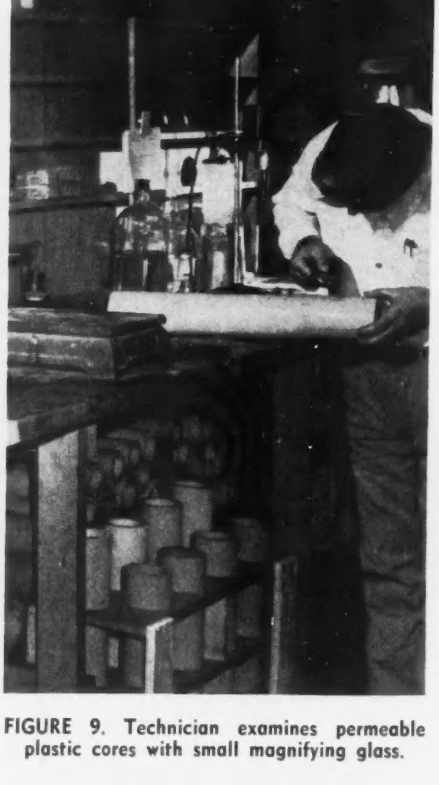

FIGURE 9. Technician examines permeable plastic cores with small magnifying glass.

Field Performance

While there have been many outstanding results obtained in the field with these new permeable plastic units, only a few will be cited to further illustrate their application in the field. On one application, small wellhead separators with cores of permeable plastic were placed on each well in a gas-distillate field. These units, installed in the flow lines upstream from the chokes, extracted sufficient distillate and water from the gas stream to prevent freezing of the line above ground even when the ambient temperatures were as low as 22° F.

Another system, troubled with ice blocks in gathering lines, was equipped with a battery of permeable plastic units. Tests showed that these units removed sufficient water to prevent the formation of hydrates, and permitted distillates to be recombined with the gas stream into a flow line without freezing at normal ground temperatures. During the severe winter of early 1951, there was not a single ice block formed in the system.

A striking example of the wide latitude of these plastic elements was demonstrated when two wells flowing 200,000 cubic feet of gas and 300 barrels of oil daily, with 4 percent basic sediment and water, were flowed through one of the units. The stream was separated into its three component liquids, with gas flowing directly from the unit into a gathering system. Oil with maximum of 0.6 percent bs&w flowed into stock tanks and salt water intermittently dumped into a nearby pit.

Investigation Continues

Development of the permeable plastic element and its application in the petroleum industry is in its infancy. Each possibility is being carefully investigated and tested, and the use of this new material not only extends into refinery and natural gasoline operations, but may solve difficult problems in other industries. The usefulness of this principle in the production of oil and gas has been well established, and no doubt there will be many other applications and developments.

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FLOODING REVIVES OKLAHOMA POOL

By ANTHONY GIBBON
WORLD OIL Staff

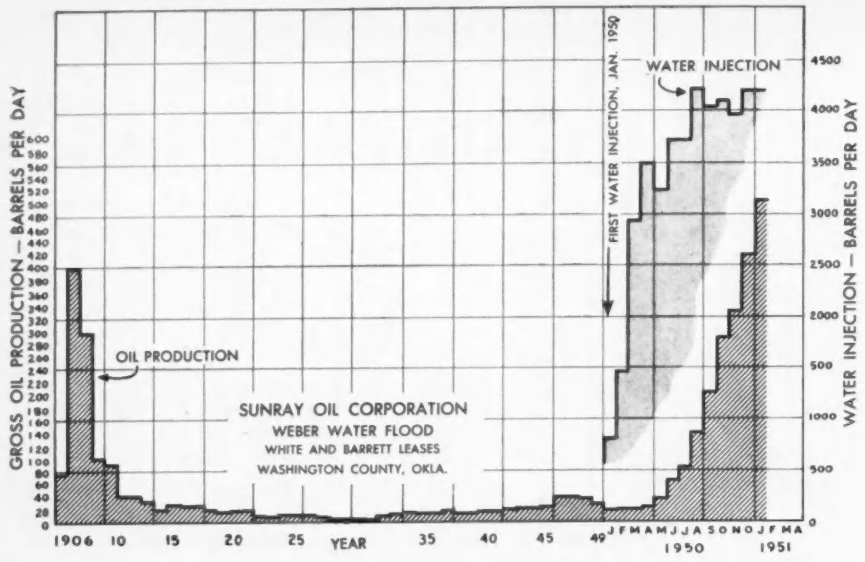
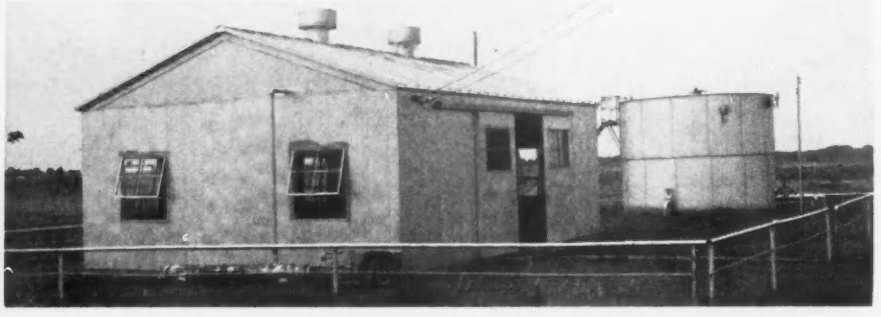

GROSS OIL PRODUCTION — BARRELS PER DAY
WATER INJECTION — BARRELS PER DAY
FIRST WATER INJECTION, JAN. 1950
WATER INJECTION
OIL PRODUCTION
SUNRAY OIL CORPORATION
WEBER WATER FLOOD
WHITE AND BARRETT LEASES
WASHINGTON COUNTY, OKLA.
1906 10 15 20 25 YEAR 35 40 45 49
J F M A M J J A S O N D J F M A
1950
1951

FIGURE 1. Oil production history of the White and Barrett leases, Weber water flood project, Washington County, Oklahoma, from 1906 to 1949, showing water flood performance and monthly volumes of water injected from January, 1950, through December, 1950.



Water supply plant at Sunray's Weber flooding project. An Arbuckle lime well produces into the 1000-barrel water storage tank shown at right.

SUNRAY OIL Corporation's operations in the old Weber pool of Washington County, Oklahoma, demonstrates the results that can be obtained by modern secondary recovery methods. This field, since its discovery in 1905, has experienced primary recovery, and when the recovery declined, pressure maintenance was begun. In January, 1950, a water injection program was initiated. By May, 1950, production had doubled.

THE Weber pool in Washington County, one of the oldest producing areas in Oklahoma, is experiencing a brisk revival under the stimulating effects of water flooding, an oil producing technique which has become widely adopted in the Mid-Continent region during the past five years. Employing the most advanced engineering practices, Sunray Oil Corporation has boosted its daily oil production on the White and Barrett leases from 30 barrels to 500 barrels since initiating the flood.

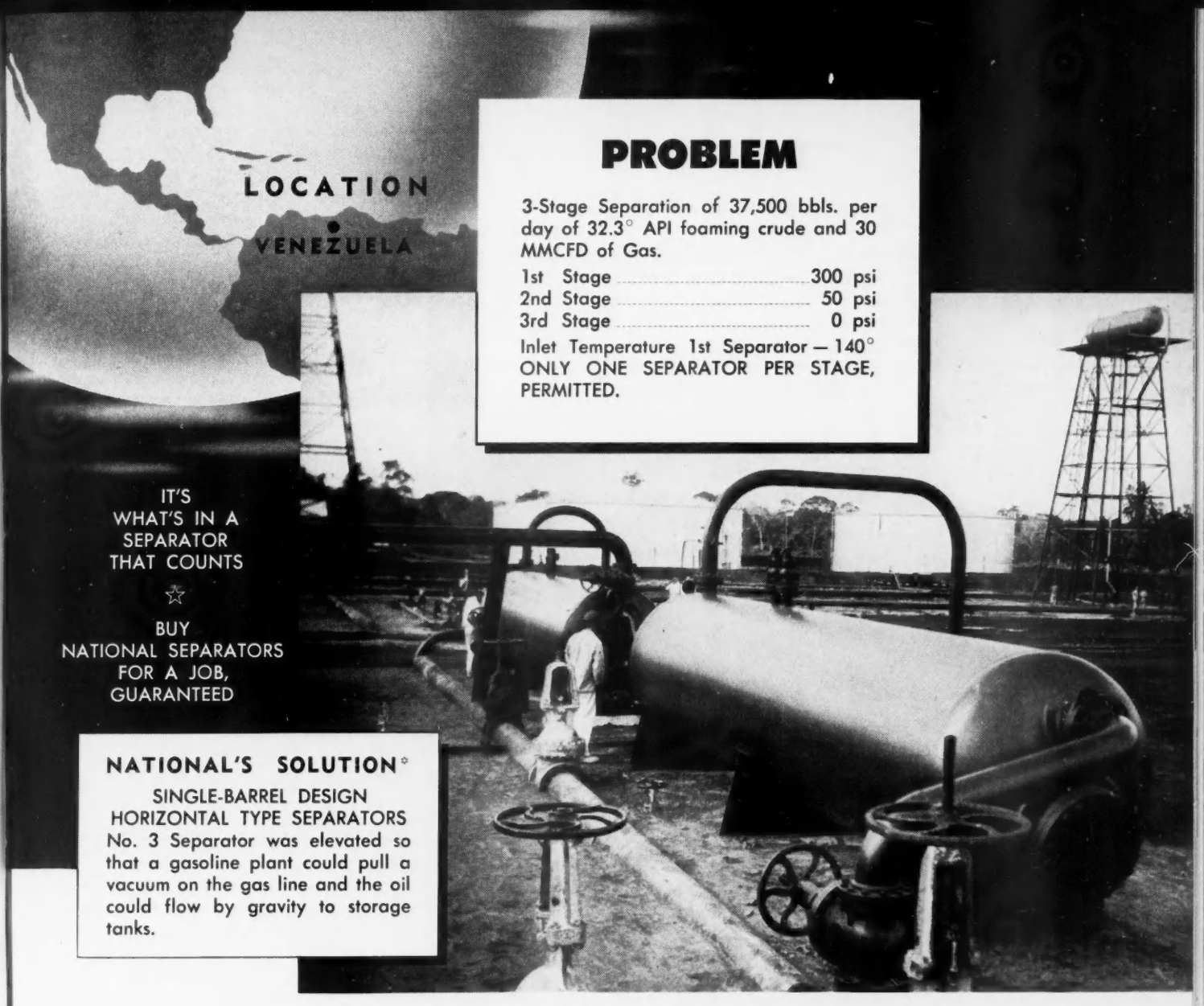
The discovery well in the Weber pool was completed November 11, 1905, at a depth of 1237 feet in the Bartlesville sand, with initial production estimated at 300 barrels per day. Pool development was rapid and by 1909 the productive limits were established and peak production reached. By 1910 activity in the field diminished as rapidly as it had begun.

In 1931 gas injection was started on the White and Barrett leases when when two old wells were used for input wells. An average of approximately 52,000 cubic feet of gas was injected daily during the first ten years of operation. Another gas injection well was completed in 1941 and an average of 87,000 cubic feet of gas was injected daily between 1941 and 1945. During the latter part of 1945 a fourth injection well was drilled and an average of approximately 127,000 cubic feet of gas was injected between 1946 and 1948. This helped maintain production under pressure and on the pump until two years ago.

Development of the property for water flooding was initiated in 1949 and the average volume of gas injected daily was decreased to approximately 75,000 cubic feet. From an extrapolation of the production decline curve it was estimated that approximately 858,000 barrels of oil, equivalent to 4767 barrels per acre or 165 barrels per acre-foot of sand, would have been produced by primary production methods and that approximately 296,000 barrels of oil or 1644 barrels per acre or 57 barrels per acre-foot of sand was the increment by repressuring and the drilling of 11 additional oil wells.

Initial developement for water flooding was limited to the 100 acres on the White and Barrett leases in 33-27n-13e. The 100-acre tract was developed on an irregular five-spot pattern with a spacing of approximately 440 feet betwen like wells. New water input wells were located so as to complete five-spot patterns by utilizing the old wells as producers. Early in 1950, development of the 80-acre Daugherty lease was started and work on this lease was completed last December and water injection was started.

Water input wells were cased with ten-inch surface casing to a depth of 20 to 40 feet, and two-inch tubing with a seven-inch casing shoe on the bottom was set and cemented on top of the oil sand. The water input wells were not shot.



PROBLEM

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2nd Stage	50 psi
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No. 2 Separator — 5′ x 22′-6″ long	50		7,200,000
No. 3 Separator — 6′ x 20′ long	0	37,500	194,000
TOTALS		37,500	30,094,000

Had only one stage of separation been utilized at 300 psi, over 7,000,000 cu. ft. per day would have been liberated in the stock tanks.

** As detailed in "TANK TOPICS," January, 1949.*

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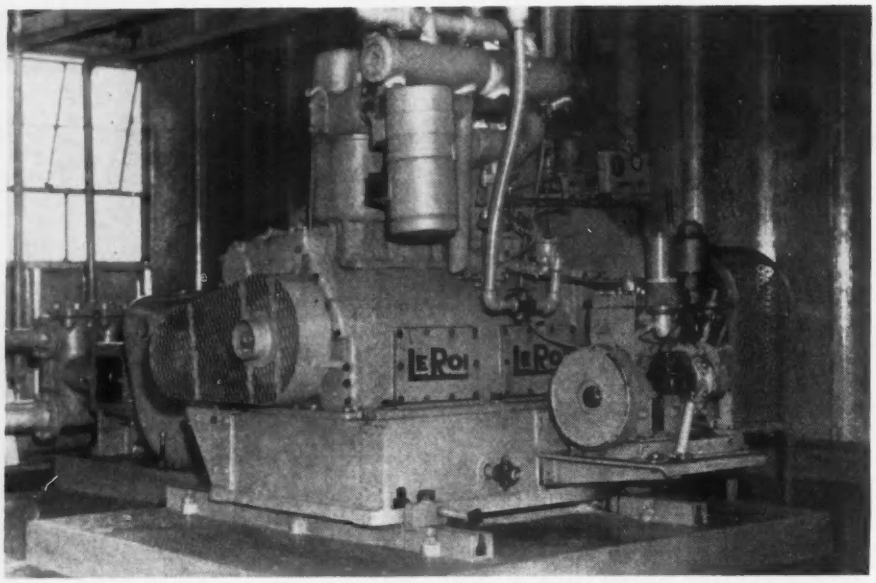
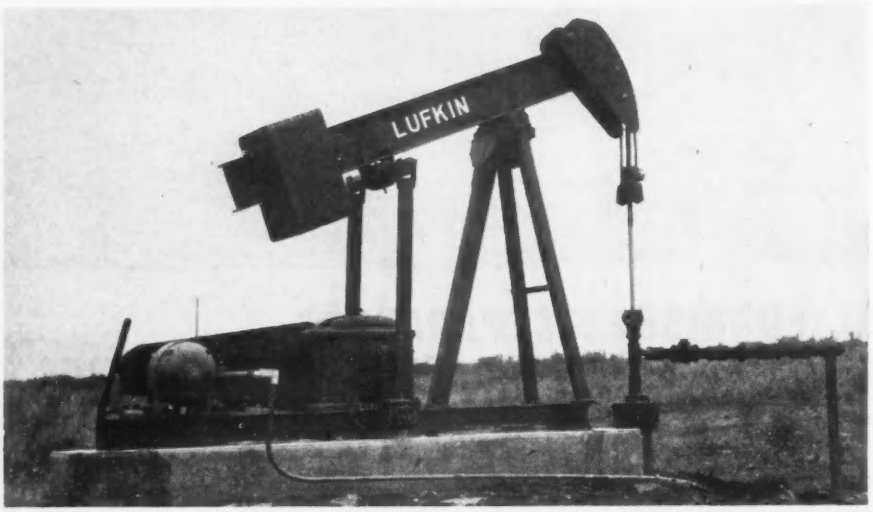
Water for flooding is obtained from a well completed in the Arbuckle limestone at a total depth of 2467 feet. A string of seven-inch casing was set and cemented at 1751 feet, top of the Arbuckle.

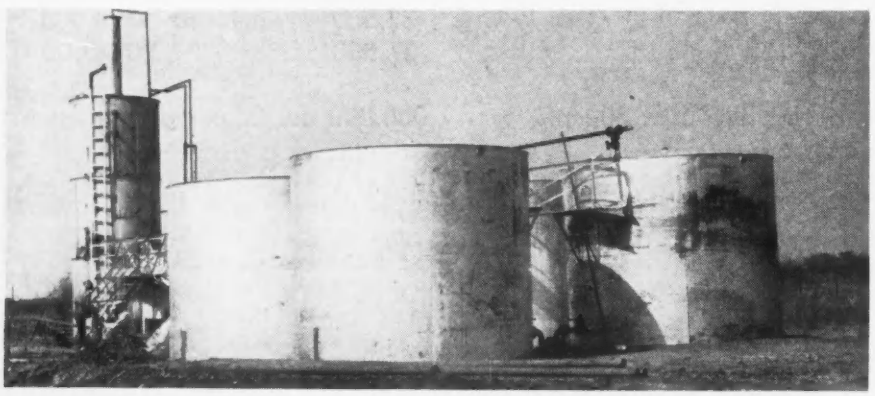
The water supply was completed prior to the completion of the drilling program but was not produced for several months. It was found upon testing that the capacity of the well was less than 2000 barrels of water daily. The dolomite section of the Arbuckle was then acidized with 5000 gallons of acid and the Rubidoux sand, between 2415 and 2450 feet, was shot with 135 quarts of nitroglycerine to increase the productivity of the well. This increased the output to at least 8000 barrels of water daily from a pumping depth of 700 feet.



Water injection pumps with gas engine drives inject water into 56 input wells on the Weber flood project.



Sunray's producing wells on the Weber water flood project are equipped with electrically driven pumping units with automatic time clock controls.



Partially-completed tank battery installed on the Weber flood project to handle the increase in oil production.

The water supply plant uses a closed system in which the water supply well produces into a 1000-barrel supply tank. A diesel-oil seal on top of the water protects it against exposure to atmosphere. A float-type, liquid-level controller operates a high fluid producing pump in the supply well to maintain the proper operating fluid level in the tank. The water-injection pumps are two gas-engine-driven 4½ x 6-inch triplex units equipped with porcelain plungers. The water is not chemically treated.

The water distribution system consists of a tapered main line made up of 4-, 3-, and 2-inch cement lined pipe with 1½-inch laterals to the input wells. The water meters, pressure gauges, and control valves are located at the input wells.

The oil gathering system consists of a four-inch main line with connecting two-inch lateral lines to the producing wells. All of the producing wells on the original 180 acres have individual electrically driven pumping units with automatic time-clock controls.

Water injection was started in January, 1950, when approximately 86 barrels of water daily, or about three barrels of water per foot of sand, was injected into each of the 28 input wells. In January, 1951, water was being injected into 56 input wells on the combined 180 acres at a rate of 7500 barrels per day.

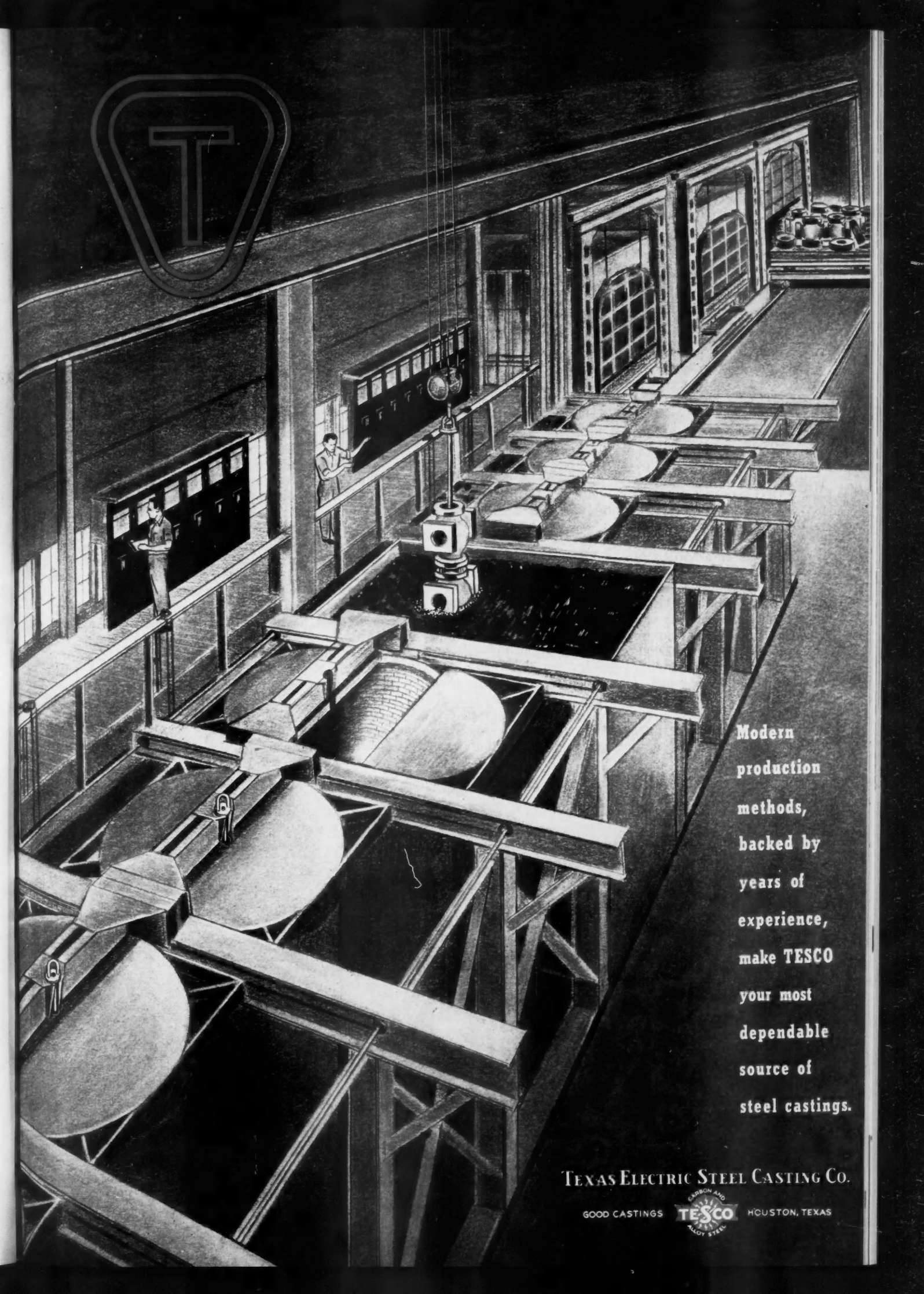
The first significant increase in the rate of oil production resulting from water flooding occurred in May, 1950, when the monthly rate of oil production on the initial 100-acre development increased from a previous monthly average of 600 barrels to 1200 barrels, a 100 percent increase.

Oil production history of the tracts flooded, by years from 1906 to 1949, inclusive, summary of water flood performance, and monthly volumes of water injected from January through December, 1950, are shown in Figure 1.

The White and Barrett leases produced 60,000 barrels of oil during 1950, the first year of water flooding.

ACKNOWLEDGMENTS

Data for above article furnished by Sunray Oil Corporation, Tulsa, and Sunray *News*.



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Unique System Speeds

LPG Fuel Tank Exchange

By GILBERT M. WILSON
WORLD OIL Staff

ONE SOLUTION to the expense involved in using and handling LPG as fuel for field equipment is presented. The hazards and time consumed in refueling LPG burning engines have been eliminated by this unique system that facilitates handling heavy-duty, small-capacity tanks and makes the transfer safer.

KEEPING pace with the constantly expanding use of liquefied petroleum gas for powering oil field equipment of all types are some of the methods that have been developed for simplifying the handling of the heavy fuel tanks in the field. A cost-saving idea was incorporated in this improved system designed for field refueling of well pulling units, certain drilling equipment installations, and other LPG-powered equipment. The new system is particularly adaptable to the problems presented when, for example, the pulling unit is set up on a well located in a remote area, miles from the nearest source of fuel or in areas not readily accessible by delivery trucks. The fact that this improved method includes a provision for a centralized, track-equipped storage rack for spare tanks also eliminates the problem of obtaining quick delivery of additional fuel on weekends, at night or when an emergency occurs.

Principal feature of the tank exchange method is the equipping of each tank with a set of four wheels and providing light channel iron tracks along which the tank can be rolled and tied down in its permanent position on the unit. The means employed for attaching the axles and wheels to the tank is such that there is no necessity of doing any welding on the tank, or in any way altering the fittings on it. The tanks used in the particular instance described are of 150-gallon capacity.

Illustrated in Figure 1 is one of the specially-equipped tanks as it was installed on a well-pulling unit. The tank was in a horizontal position and positioned on the channel iron tracks which were laid across the truck frame between the cab and the pulling unit engine. Two heavy steel straps were clamped around the tank, the axles and wheels being attached to them. The tank was held in position by a permanent stop on the far end of each track, a removable stop on the front end and a pair of anchor bolts which loop over the axles and were tightened against the frame.

The straps which encircle the tank were made in two half-circle sections easily installed and tightened down with one-half-inch bolts that engaged matching ears on either side of the tank. The lower sections, to which the dolly or axle units were welded, consisted of ⅜- by 2½-inch steel bar and the upper halves were made of ⅜- by 2-inch material. Distance between the centers of the two straps was 38 inches. Two sturdy hand grips of

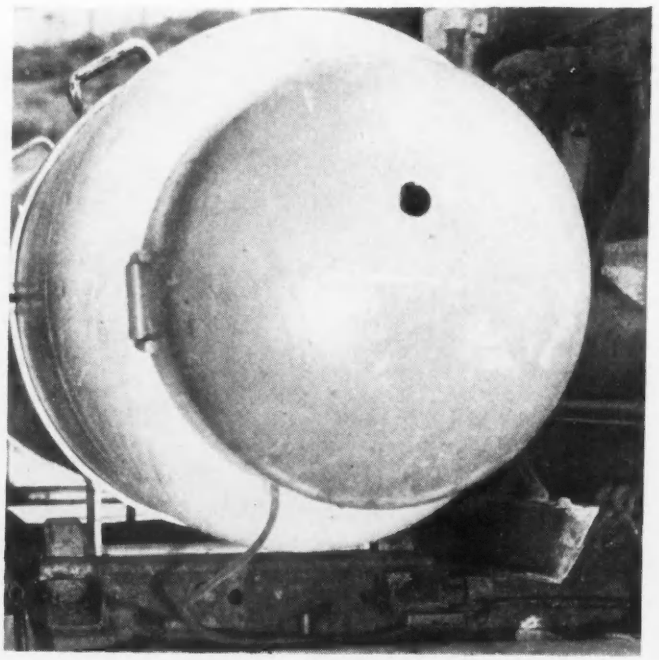
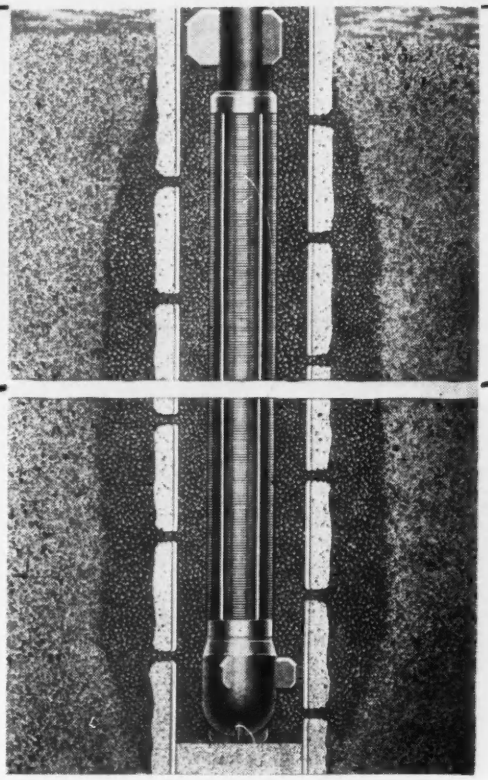


FIGURE 1. Equipped with wheels and laid horizontally on a pair of channel iron tracks, this LPG fuel tank is easily rolled off and replaced with a similarly-equipped full one. The tank was mounted across the frame of a well pulling unit, between the cab and the hoisting engine.

THE LAYNE WAY



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round bar stock were welded to each strap, these provided grips which facilitated the loading and unloading of heavy LPG tanks.

Solid Wheels

The axles were made of round bar stock material and the wheels of solid steel, cut out of 2½-inch thick plate. The wheels are 4½ inches in diameter. As shown, the wheels roll in tracks consisting of lengths of 3- by 1½-inch channel. Far ends of the channel have permanent stops welded across them, but on the front end, the stop is a removable device which extends across the front ends of both tracks and which consists of a length of round bar to which has been welded a piece of plate. The unit was held in place with a single bolt. A three-fourths-inch anchor bolt, connected to the truck frame, is looped over each axle and cinched down tightly to hold the tank rigidly in position. The tracks are 18½ inches apart, center to center.

Loading and unloading of the tanks was accomplished with a minimum of physical exertion on the part of the men who do the job. Assisting in this operation of exchanging or transferring tanks was a specially-designed loading ramp made from two 4-foot pieces of channel iron and welded together so that the channels have the same gauge as the tracks on the pulling unit. This ramp was designed to span the interval between the pulling unit and the bed of the pickup or flat bed truck which transported the new tank. A short round pin welded to the under side of the front lip of each track of the ramp was designed to drop into a matching hole burned in a piece of flat bar stock welded on the loading end of each track on the pulling unit. Using this loading ramp, it became a simple matter to back up the truck to the pulling unit, roll off the empty tank, then roll on the full one.

Storage Rack

Essentially the same procedure was followed in removing and exchanging tanks from the small skid-base storage rack designed for easy moving and spotting at any convenient or centralized point in the field office yard or elsewhere on the lease. This rack, built primarily of two-inch pipe materials, is of all-welded construction. Illustrated in Figure 2, the rack is a rectangular structure whose base section is five feet long and four feet wide. The channel iron tracks welded to the base section are 44 inches above the level of the ground.

In order to make use of the truck winch to assist in pulling full tanks up on the storage rack, a head frame made of two-inch pipe was built on the rear end of the unit. On the 2½-inch pipe horizontal member of this frame were mounted two 8-inch sheaves, each being centered over one of the pairs of tracks. When newly-filled tanks are brought out to be placed on the rack, the truck winch line is pulled out, run over the sheave and attached to the tank hand grips, after which winch power can be applied to pull the tank up on the rack. The head frame has an over-all width of approximately 68 inches and a vertical height, between the sheave axle and the tracks, of approximately three feet.

More constructional details of the wheels, tracks and loading ramp device can be seen in Figure 3. Visible in the foreground are the small metal tabs that are welded to the ends of the tracks and to which are attached the ends of the loading ramp to build a continuous track between the rack and the delivery truck bed. Also visible in Figure 3 are the short U-bolts with which the tanks are anchored to the rack.

Numerous advantages accrue from this method of handling liquefied petroleum gas fuel tanks. The cost of fabricating the axle and wheel assemblies is moderate, particularly if a number of identical units can be made up at one time. Generally, it is not convenient to exchange tanks at the exact time that fuel is needed or to order out a supply company for refilling the empty tank at any time of the day or night. With the present system, it is a simple matter for a crew going off tour or anyone going to the shop with the pickup truck, to bring back a full tank and exchange it in a relatively short time.

While the particular field unit installation described is on a well-pulling unit, the system easily is adaptable to other uses such as on standby equipment on drilling rigs or other field activities.

When due consideration is taken of all factors involved, such as the saving in man- and equipment-hours, increased safety to the men who handle the heavy tanks, together with the convenience of being able to exchange tanks on short notice at any time of the day or night, the cost of outfitting field equipment with this type of wheel and track system can be repaid in a short time.

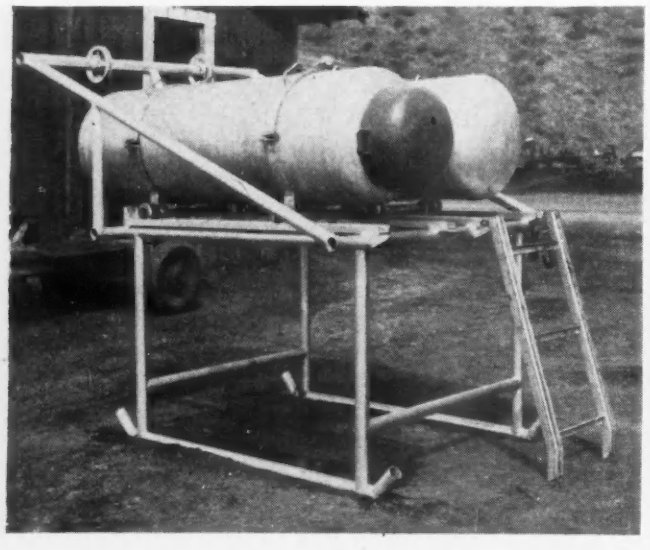


FIGURE 2 (left). Contributing to the value of the wheel and track system is this skid-base mounted storage rack which holds spare tanks. It is also equipped with channel iron tracks. Using a special ramp, men can easily roll tanks on or off. This view shows the head frame on which are mounted sheaves that permit use of a winch line in pulling loaded tanks up on rack.

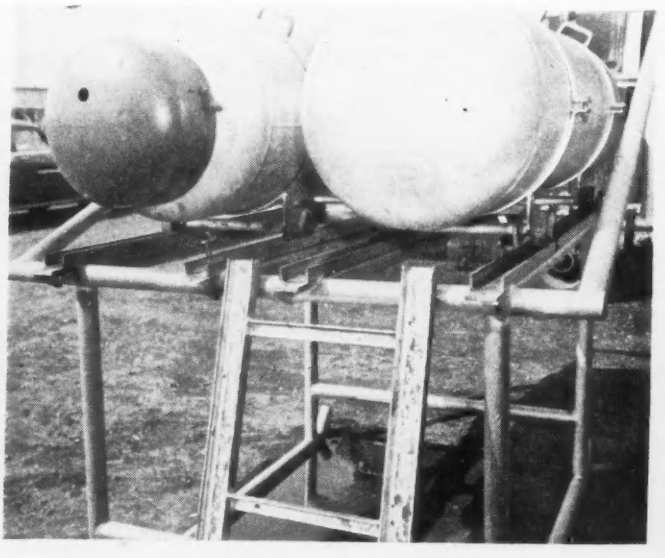
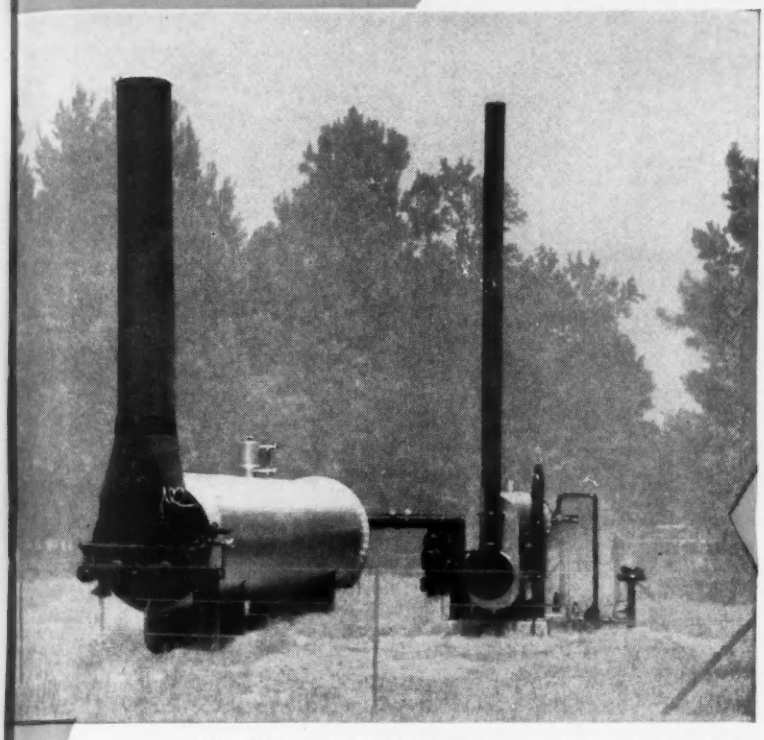


FIGURE 3 (right). Additional details of construction of the track and wheel system. In foreground, leaning up against the front of the rack, is the loading ramp which is used to form a continuous track between the truck and the front lips of the tracks.



BS&B 70G indirect heater on Carthage, Tex. system. (Right) a 10 year-old BS&B indirect heater still in use for auxiliary service.

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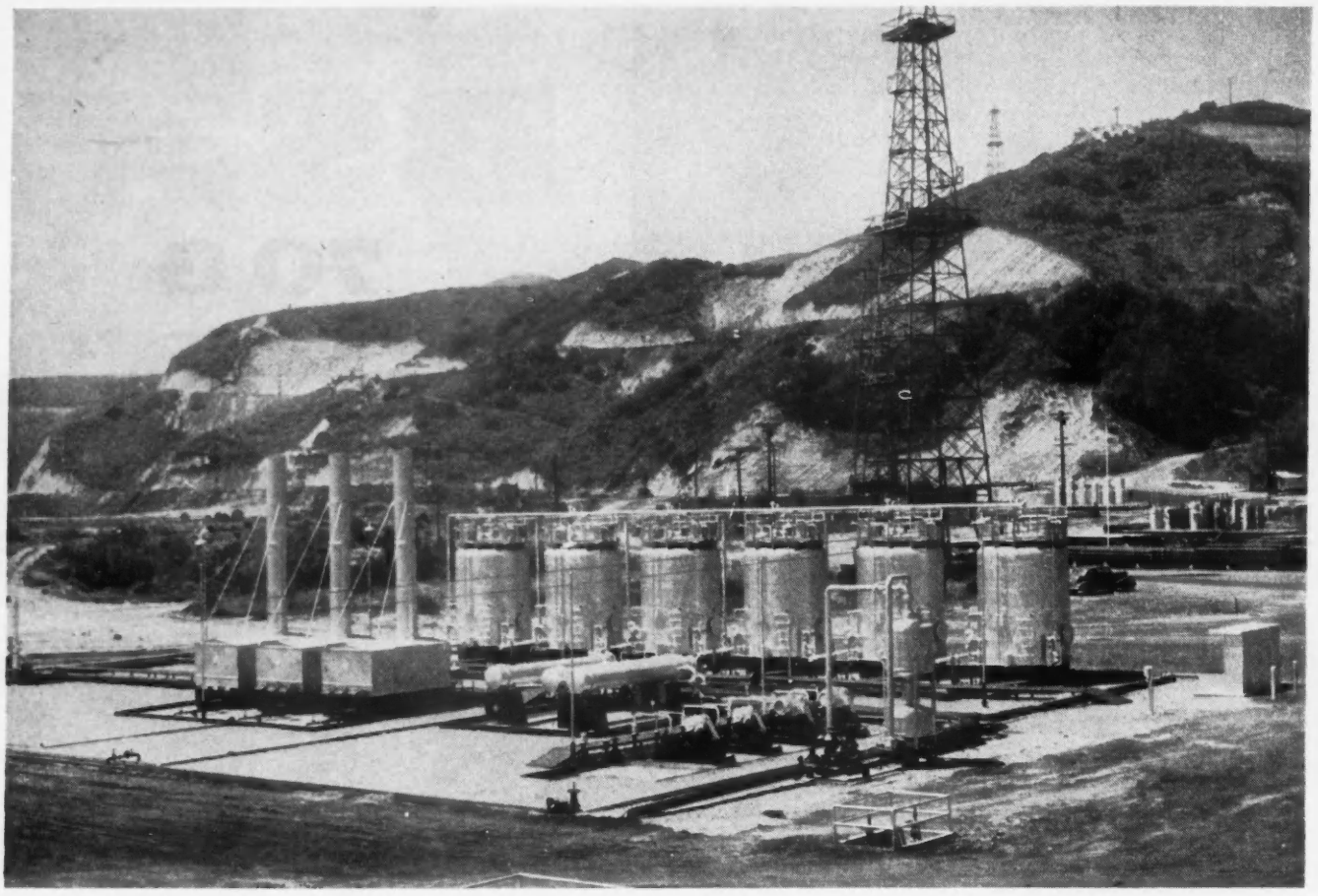

Typical central pumping installation in a California field for electric dehydration of heavy crudes. In front of dehydrators are heaters, exchangers and pumping equipment.

Electric Dehydration of Heavy Crudes

By ROBERT L. PETTEFER
Petroleum Rectifying Company of California, Long Beach

LATEST METHODS of electrically dehydrating emulsified crudes of extremely low API gravity are described. Although the use of an electric current to break difficult emulsions is not new, it has been used effectively in conjunction with automatically-operated equipment to satisfactorily condition these heavy crudes for pipe line sales.

HEAVY crudes in the 10 to 20 degrees API range present treating problems not encountered in crudes of higher gravities. With increased demands for heavy crude, the treating problem assumes significant proportions and engineers and technicians are exploring new ways which offer more effective and economical results in treating such oils and conditioning them for the pipe line. Because California produces considerable quantities of heavy oil, the problem has received more intense study there than in other areas and new techniques have been developed which are applicable to similar heavy-type crudes produced in other parts of the country.

A method which has been tried successfully in treating California heavy crude is a field installation utilizing a high-potential electric field to resolve crude emulsions. Before describing this technique, it should be pointed out that wet oil emulsions are formed when oil and water are agitated so that one of the liquids is broken into small drops which are dispersed into the surrounding liquid. If these two components were pure liquids, the dispersion would be only temporary; the dispersed drops would coalesce and the two liquids would separate quite readily. In most oil fiields, the oil or water or both contain emulsifying agents which stabilize the dispersions. The kind and quantity of emulsifying agent present and the severity of agitation determine the stability of the emulsion. With heavier crudes, the low gravity and high viscosity of the oil complicate this separation even further, because the water droplets settle out very slowly due to the oil's viscosity and the small differential between the weights of the oil and water.

Action of the high-potential electric field in resolving crude oil emulsions appears at first sight to be a relatively simple proces. However, many factors are involved in bringing about the complete and rapid resolution required in oil field practice; and the heavy crudes involve the use of tech-

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Hardness in nickel cast irons results from improvement of the matrix. Chilled areas and hard carbides, which impair machinability, are obviated. Nickel improves response to heat treating. In fact, use of nickel alone or with other alloying elements plays an important part in meeting a variety of requirements.

Accordingly . . . nickel alloyed irons permit production of castings with high levels of the following properties:

Strength

Tensile and transverse strengths of castings are greatly increased by the addition of nickel to cast irons of properly adjusted base mixture. The ratio of compressive strength to tensile strength is retained. Greater uniformity of strength in thick and thin sections is achieved.

Elasticity

The elastic modulus increases with strength. In this respect nickel-containing irons of the high strength type possess good stiffness and do not deform permanently under loads that would be damaging to irons of lower elastic modulus.

Damping Capacity

The damping capacity inherent in gray cast iron is not impaired by the presence of nickel.

Wear Resistance

The uniformly pearlitic matrix of nickel cast irons appreciably improves wear resistance. The uniformly fine graphite flake distribution, achieved in suitably processed irons *without formation of a poor wearing dendritic condition,* affords optimum resistance to wear and galling.

Pressure Tightness

Characterized by dense grain structure and fine dispersion of graphite throughout, nickel alloy irons are close-grained and offer an extraordinary degree of pressure tightness under high hydrostatic pressures, without sacrificing machinability.

Applications

Heavy machinery frames and *beds* are typical of cast parts that benefit from the rigidity and good damping capacity of nickel cast irons. *Cylinder* and *pump liners, gears, dies, machine tool ways, saddles* and *tables* exemplify parts produced in nickel irons to assure greatly increased strength and wear resistance. And nickel alloyed iron is used for *heavy duty brake drums* to resist heat checking, thermal shock, wear and galling. The nickel cast irons are readily heat treated, and respond particularly well to flame and induction hardening.

At the present time, the bulk of the nickel produced is being diverted to defense. Through application to the appropriate authorities, nickel is obtainable for the production of engineering nickel cast irons for many end uses in defense and defense supporting industries.

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niques and methods not required by lighter oils.

The electric dehydrator described is a self-contained unit consisting of a vapor-tight pressure vessel, and automatically controlled electric circuit and other auxiliary equipment. The emulsion to be dehydrated flows into the dehydrator where the electric field separates the oil and water. The water is drawn off continuously from the bottom of the vessel and the dry oil flows out the top of the unit.

Electrical Field Effect

This separation is effected because the electric fiield disturbs the absorbed emulsifying film on each water drop, probably by causing the polar molecules in this film to re-orient themselves. This re-orientation weakens the film about each drop because the polar molecules are no longer tightly absorbed at the surface of the drop. In addition, there is a mutual attraction of adjacent drops which are given induced charges by the applied electric field, thus causing them to have a tendency to line up along the electrostatic lines of force with oppositely charged portions of adjacent drops in close proximity to one another. Since the absorbed film is no longer stable, the adjacent drops can now coalesce freely. In this way, the drops grow in size until they are heavy enough to settle out of the oil by gravity.

The effectiveness of the electric field is largely due to the design of the electrode system and many electrode systems have been devised for dehydrating crude oil emulsions. For the purposes of this discussion it may be considered that they fall into two general classes, based principally on the rate of flow of the emulsion through the electric field. The two electrode systems are classed as:

- The low-velocity type (for treating heavy crudes).
- The high-velocity type (not generally used for treating heavy crudes).

The choice of electrodes for a given job is determined in advance of the actual field installation by dehydrating a sample of the emulsion in question through a miniature electric dehydrator. This test can be made in the laboratory or in the oil field.

Since this article deals particularly with the treatment of heavy crudes, only the low-velocity electrode system will be described.

The low-velocity electrode system consists of two horizontal and parallel electrodes of differing electric potential. Each electrode is composed of a series of concentric rings in a horizontal plane, and the two are suspended by insulators one above the other in the upper portion of the vessel. A suitable inlet distributor or spreader introduces the emulsion into the dehydrator below the electrodes where it flows upward into the electric field. Here the water particles in the emulsion coalesce and fall to the bottom of the tank, where the water is drawn off continuously by an automatic water level controller so that the water level will always be well below the electrodes.

The dehydrated oil passes upward and out of the tank through an outlet at the top of the dehydrator. This electrode system sets up an electrostatic field over the entire cross-section of the tank so that all the oil must pass through the electric field before it leaves the tank. This type of electrode is suitable for emulsions which have a relatively low electrical conductivity and is especially useful in the treatment of heavy crudes which require quiet flow conditions to promote good settling. The usual applied voltages range from 11,000 to 33,000 volts. The average power consumption is 17 kilowatt hours per 24-hour day in flow line plants and 40 kilowatt hours per 24-hour day in central pumping plants.

There are two general systems for applying electric dehydration in the treatment of heavy crudes: the central pumping plant system, and the flow line system.

Central Pumping Plant System

In the central pumping plant system, the wet oil from the wells is produced into a central wet oil tank. An electric, or power-driven, variable-speed pump takes suction from the wet oil tank and pumps the wet oil through the dehydrating plant. Figure 1 presents the flow diagram of a plant of this type. The speed of the wet oil pump can be governed by a float-operated controller on the wet oil tank. The desired liquid level is thereby maintained automatically in the wet oil tank. On properties which do not produce enough oil to make continuous operation economical, it is often desirable to produce the oil into the wet oil tank until it is full. The dehydrating plant can then be started up and run until the wet oil tank is empty. Here again, a float switch can be used to shut down the dehydrating plant when the wet oil tank has been emptied. A thermostat on the heater maintains the desired temperature. The heat exchanger delivers the heat from the clean hot oil, leaving the dehydrator to the cold emulsion from the dehydrator feed pump. The clean oil is thus delivered to storage at a reduced temperature so that gravity losses due to evaporation are eliminated. Heat exchangers can be used where it is necessary to heat the emulsion before treating it.

The elimination of gravity losses due to to evaporation is achieved because the dehydrator shell is a vapor-tight tank. Dehydrator tanks are available for any desired operating

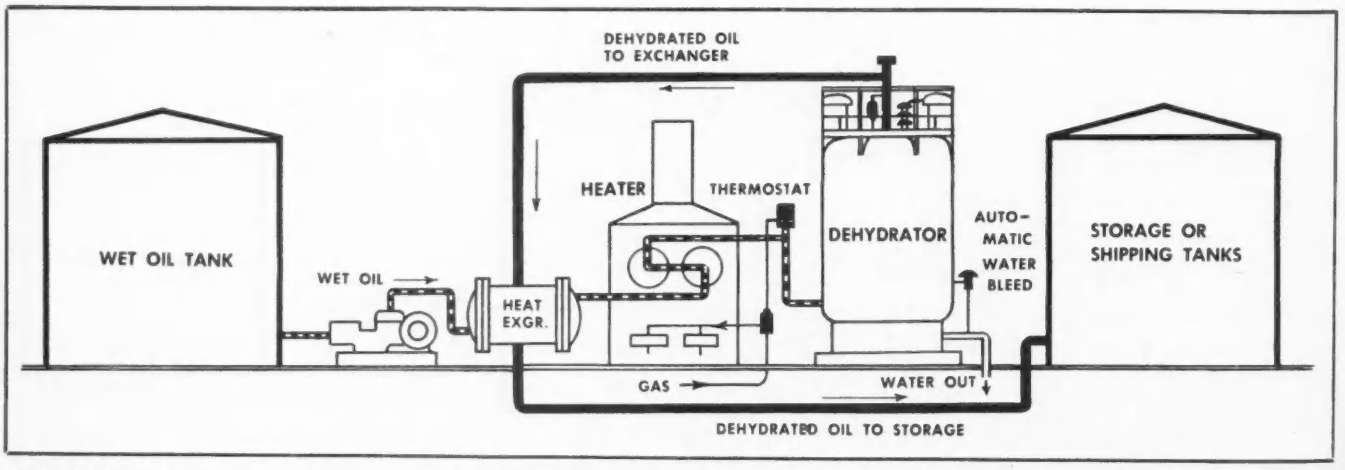
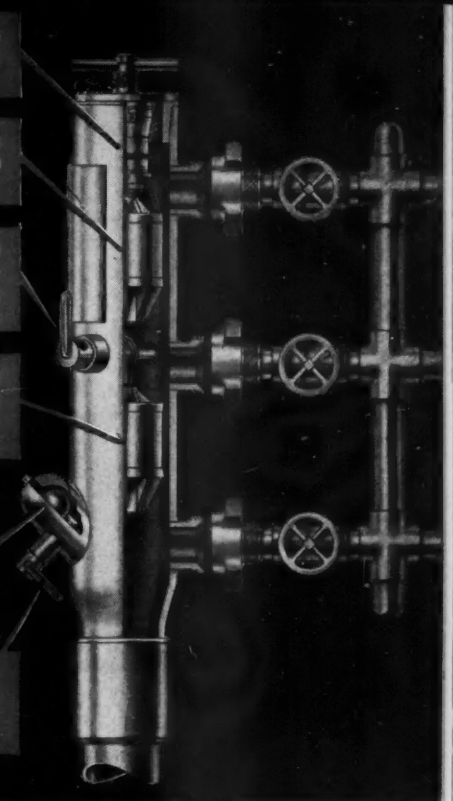


FIGURE 1. Flow diagram of a central pumping plant system showing the relations of the various pieces of equipment and flow of fluid through the system.

From HEAD to SHOE


Back pressure valve connected to top plug.
Top plug rides cement column down the casing.
Plug bar releases bottom plug without shutting down or opening head.
Bottom plug leads cement column and wipes casing clean of mud.
Trip ball that ejects float assembly in shoe to provide full casing-bore discharge.
Ball dropper releases trip ball without opening head.

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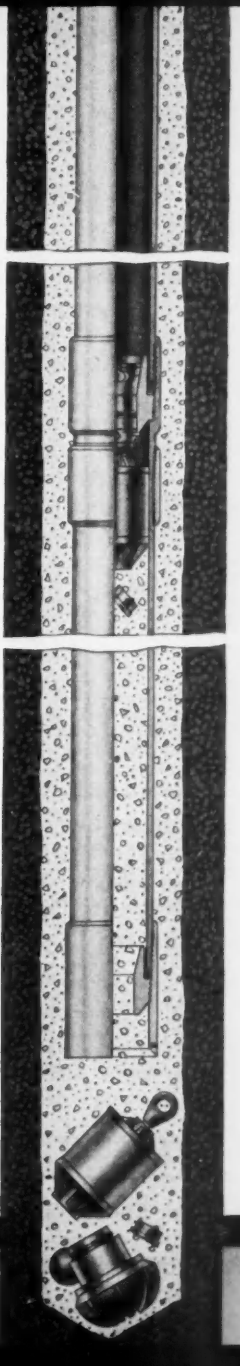

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pressure. If the oil were heated in a low-pressure tank or an open tank, a certain amount of evaporative gravity loss would be virtually unavoidable because such tanks cannot be operated at a pressure sufficient to force the heated oil through an exchanger or cooling tower.

Flow Line Dehydration System

One of the principal advantages of flow line dehydration is that it permits the emulsified crude from one or more wells to be treated before it has had a chance to age and become tough. Figure 2 shows a typical diagram for an automatic flow line system. The wet oil from one or more oil wells flows through a gas trap, then through the dehydrator, and finally into dry oil storage. In many cases no heat is needed other than the natural heat of the oil as it is produced, because the emulsion is fresh and has not had time to become stable. In cases where the emulsion cannot be dehydrated at the producing temperature, it is customary to install a thermostatically controlled heater in the flow line to raise the temperature of the wet oil. In many cases the waste heat from some available source can be utilized.

The fact that the oil can be produced directly through a flow-line dehydrator gives the producer the same advantages he has when producing a clean well because the dry oil delivered to the stock tanks is ready to ship.

With either the central pumping or the flow line systems, the treatment of heavy crudes frequently calls for the application of heat. An electric dehydrator can be used in conjunction with many types of heating systems and it is often possible to make use of heating facilities already available on the lease.

In the low-pressure steam heating system, steam pressure is usually maintained at approximately 15 pounds per square inch. Steam lines to the heat exchanger are located higher than the top of the boiler so that as the steam condenses in the exchanger, it flows back into the boiler by gravity, thereby eliminating the necessity for make-up water. When lease conditions make it necessary to place the exchanger lower than the top of the boiler, it is customary to use a small, electrically driven rotary pump in the condensate line, which returns the condensate directly to the boiler continuously, thereby eliminating the necessity of using a boiler feed water tank.

The circulating hot-water heating system employs a pump that circulates water continuously through the heater and the hot-water-to-oil heat exchanger. The temperature is thermostatically controlled.

Direct-flame pipe heaters or tube still heaters are satisfactory where it is possible to maintain a high fluid velocity through the tubes at all times.

Where high heating efficiency in a single dehydrating unit is essential, an electric dehydrator with an internal fire tube heater may be used. This heating unit is similar to the one commonly used in the heating and settling type of emulsion treaters used throughout the oil fields. The fire tube is immersed in the water layer, and a very even temperature distribution is gained. This internal type heating unit is economical because it eliminates the cost of installing a separate heating system and heating system piping, utilizes less ground space, and delivers higher heating efficiency with less temperature fluctuations. Internal fire tube heaters are automatic in operation, economical to maintain and completely safe because the heating tube is completely immersed in the water layer which is held constant by an automatic water level controller.

Automatic Controls

Electric dehydrators in California operate automatically and require minimum attention. The controlling devices which effect this automatic operation consist of:

- A choke coil in the power circuit limits the current consumed and controls a meter and pilot light indicating that pipe-line oil is flowing from the dehydrator to the stock tanks.
- A float-operated switch cuts off all power when the dehydrator shell is not completely filled with liquid.
- An automatic water bleeder drains the emulsion water from the dehydrator and holds the water at the desired level in the vessel.
- A thermostat controls the heater so that the emulsion entering the dehydrator is always at the desired temperature.
- A float-operated controller installed at the wet oil tank controls the dehydrator feed pump, making it possible for the pumper to go about his other duties since the pumping of the oil can be completely automatic.

About the Author

ROBERT L. PETTEFER was graduated from U.C.L.A. in June, 1929. He has been employed continuously since that time by Petroleum Rectifying Company, and is now district engineer for the California district. He is a member of AIME.

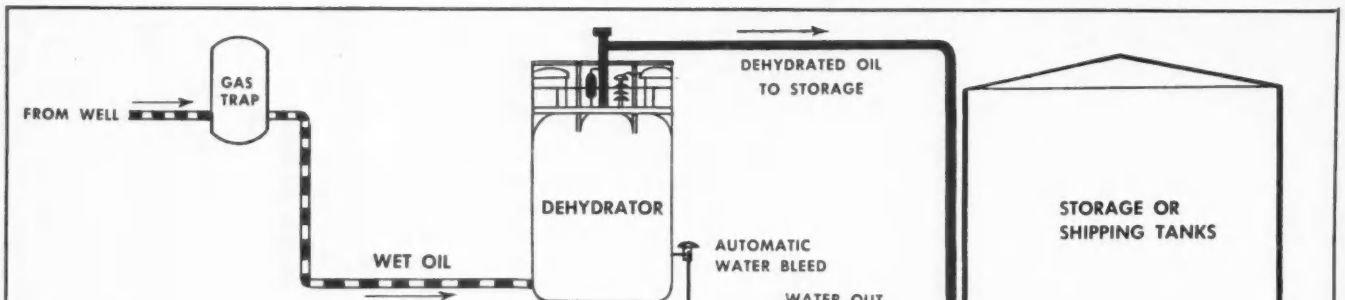

FIGURE 2. Automatic flow line dehydration system where the wet oil is continuously treated and thereby prevented from aging and becoming "tough."

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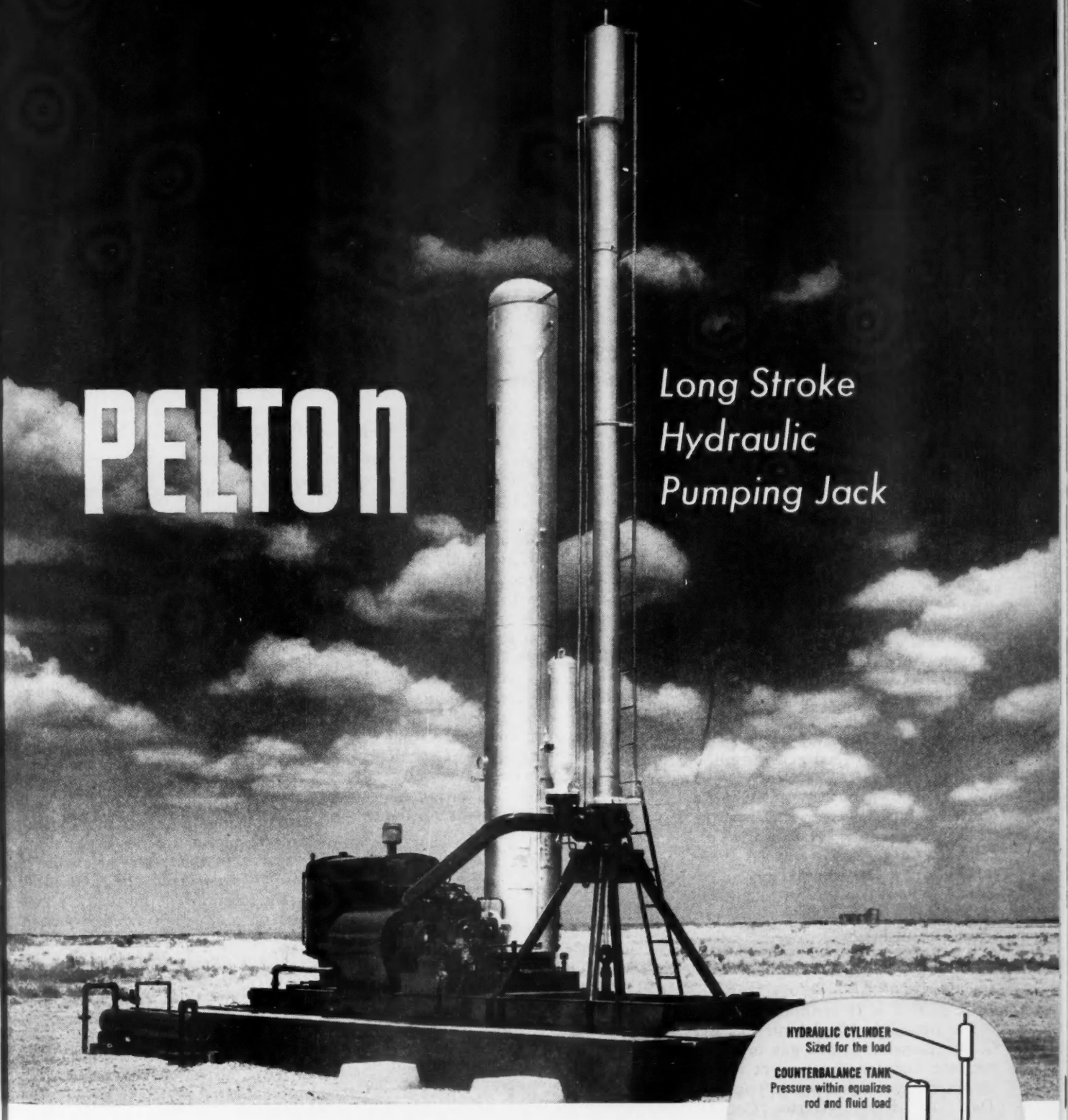
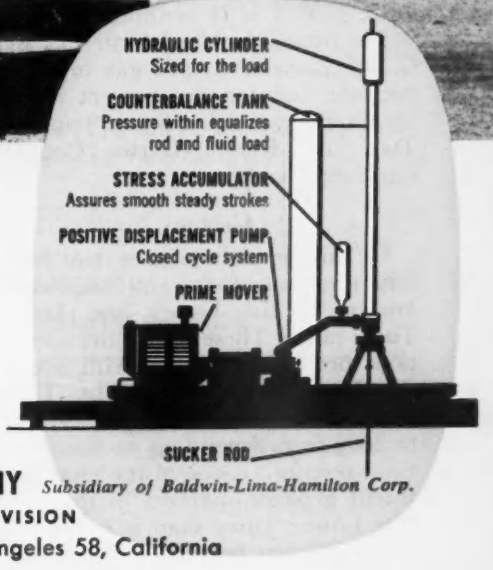
Long Stroke Hydraulic Pumping Jack





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Effects of Gas Injection In Low Gravity Oil Pool

By RAY STAPLES
Cable & Staples, Wichita Falls, Texas

RESULTS OF a gas injection program in a heavy crude reservoir are presented. Many difficulties had to be overcome in placing this program in operation. Geologic features of this Southern Oklahoma field posed somewhat of a problem. Gas injection and water flooding of such reservoirs depends upon many factors, and the author discusses some of these at length. Production decline curves on a field wide basis and on an individual well basis point out the success of this project.

RESULTS of pressure maintenance and repressuring projects in reservoirs that produce low gravity oil have always been a subject of considerable interest to production engineers, because a major factor influencing the success of such a project is the reservoir oil viscosity. There is a limit to the maximum viscosity for oil produced from a reservoir that will respond successfully to gas or water injection. While this fact is recognized generally, the maximum viscosity in either case is not well known quantitatively. As a matter of fact, however, the reservoir mobility index, a product of the permeability and viscosity, is more significant in determining these limits.

The following describes a pressure maintenance program which has been in successful operation for 3½ years in a reservoir where the produced oil has a gravity of 23-25 degrees API, and the viscosity at reservoir temperature 110° F is 29 centipoises.

The project is Allied Materials and C. W. Barbour et al's gas injection pressure maintenance project in the Lower Tussy Sand in Sects. 9 and 10, Twp. 1S, R-3W, Carter County, southern Oklahoma.

Geology

In this immediate area two horizons are commercial and are locally known as the Upper and Lower Tussy sands. These producing formations probably correlate with one of the Deese sand series. The Tussy lime, penetrated at a depth of 2500 to 2800 feet, depending on the structural position, is one of the most persistent geologic markers in the area. The Lower Tussy sand is penetrated 75 to 100 feet below the Tussy lime. The Upper Tussy sand, which lies directly on top of the Tussy lime, was not included in the pressure maintenance program.

The formations dip steeply in this locality as they are deposited on the flanks of the Arbuckle Uplift, a prominent geologic feature in the area. Maximum relief between the crest of the structure and the downdip limits of production is approximately 300 feet. The reservoir is a lenticular sand deposit; hence, the sand condition, as well as its structural position, is a factor in determining the productive limits. A sand pinchout occurs structurally high on the east boundary of the reservoir. The original water-oil contact was found at —1890 subsea on the west side of the reservoir. Some faulting may have occurred also, as indicated on the structure map.

Data and Development

The Lower Tussy sand, as reflected by the electric logs and the available core analyses data, is a well-developed, clean sand ranging in saturated sand thickness from 22 to 47 feet. Two core analyses are available: the C. W. Barbour's Gray A-4 well and The Texas Company's Pennington 1. The 14-foot section cored in Gray A-4 shows an average permeability of 1247 millidarcys and porosity of 27.2 percent. The 22 feet cored in the Pennington 1 reveals an average permeability of 1082 millidarcys and porosity of 23.9 percent.

As the initial development of this reservoir was begun in 1943, the Lower Tussy sand was developed on 20-acre spacing in accordance with wartime regulations. Since a gas cap was present in this reservoir, casing was usually set through the sand and the pay section perforated. This method of completion aided in controlling the gas-oil ratios of wells located structurally high.

Pressure maintenance by both gas and water injection was considered for the Upper and Lower Tussy sands, but it was decided to inject only gas into the gas cap of the Lower Tussy sand. For this project a two-stage compressor rated at 143 brake horsepower, with a capacity of 700,000 cubic feet per day at a suction and discharge pressure of 20 and 820 pounds per square inch gauge respectively was selected.

The selection of a key well presented a problem, since there were some differences of opinion as to whether Gray C-1 was completed in the Lower or Upper Tussy sand gas cap. Those who believed Gray C-1 was completed in the Lower Tussy sand wished to use this well, because it was a gas well and could not be produced. Others wished to use Gray A-4, which overyone agreed was com-

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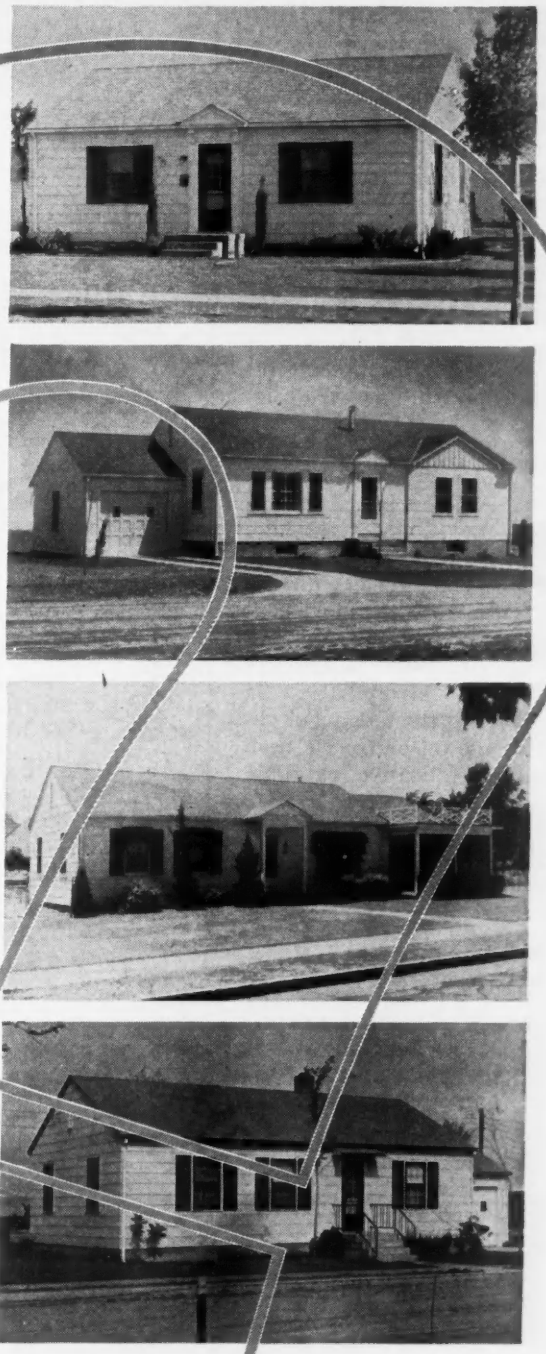

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pleted in the Lower Tussy sand. Gray A-4, a high gas-oil ratio well with a large part of the producing sand section in the gas zone, would have made an excellent key well; however, Gray C-1 was finally selected as the key well. It was believed that the maximum compressor capacity of 700 to 800 Mcf per day could be injected into the 50 feet of gas sand in Gray C-1 without any difficulty or adverse effects on any producing wells.

At the inception of the project, all producing wells were pumping and the bottom-hole pressure was 575 psig.

Initial Injection

In January, 1948, an initial gas injection volume of 150 Mcf per day was injected. This volume was gradually increased to 260 Mcf per day by April of the same year, during which time the production increased in Gray A-9, an offset producer to the gas key well Gray C-1, from 70 to 96 barrels per day; but the volume of gas produced with the oil had more than doubled, a fact indicative of rapid gas movement from the key well to the producer. Such a condition is very hazardous to any injection program, if not controlled.

It became necessary, therefore, to hold a casinghead back-pressure of 300 psig on this pumping well in order to control adequately the gas-oil ratio. By controlling the gas produced with the oil from Gray A-9, it was found that 350 Mcf of gas per day was the maximum feasible volume to be injected into Gray C-1. This situation presented an unexpected problem, as this volume was approximately 50 percent of the compressor capacity.

About the Author

RAY STAPLES graduated from the University of Tulsa with a B.S. degree in petroleum engineering, and in 1941 was employed as a petroleum engineer in charge of a water-flood project in Southeastern Kansas. He resigned to become a petroleum engineer with the U. S. Department of the Interior. In 1944, he became associated with Cable & Stine, Wichita Falls, Texas, and in 1949 was made a partner in the firm. On October 1, 1951, he became associated with Jo H. Cable in consulting petroleum engineering under the firm name of Cable & Staples.

Furthermore, an additional key well was required if the desired volume of gas was to be returned to the reservoir. Gray A-4 was the most favorable for a key well at that time, but because of legal difficulties it could not be used. A key well location east of Gray A-4 was recommended to be drilled, but an alternate, Gray A-8, a well low on the producing structure, was selected and placed in operation in November, 1948.

In March, 1949, it was decided to reduce the daily gas injection rate in Gray C-1 and the well was shut in completely for the month of April. This was done in an endeavor to improve the gas-oil ratio of Gray A-9 while observing reservoir reaction at the same time. Beginning in May, 1949, the gas volumes were steadily increased in both Gray C-1 and Gray A-8 to a maximum slightly in excess of 600 Mcf per day by March, 1950.

The reduction in input gas volume, and subsequent increase, will give some idea relative to the reservoir performance both with and without gas injection. An inspection of the Production Decline Curve shows an increase in oil produced during the months of March through May, 1949, the result of additional wells completed. These new wells were fill-in locations developing the favorable areas on ten-acre spacing rather than the former 20-acre war-time spacing.

It will be noted on the Reservoir Performance Curves that the daily production reached its peak when the volume of gas injected was relatively low. After reaching a peak in June,

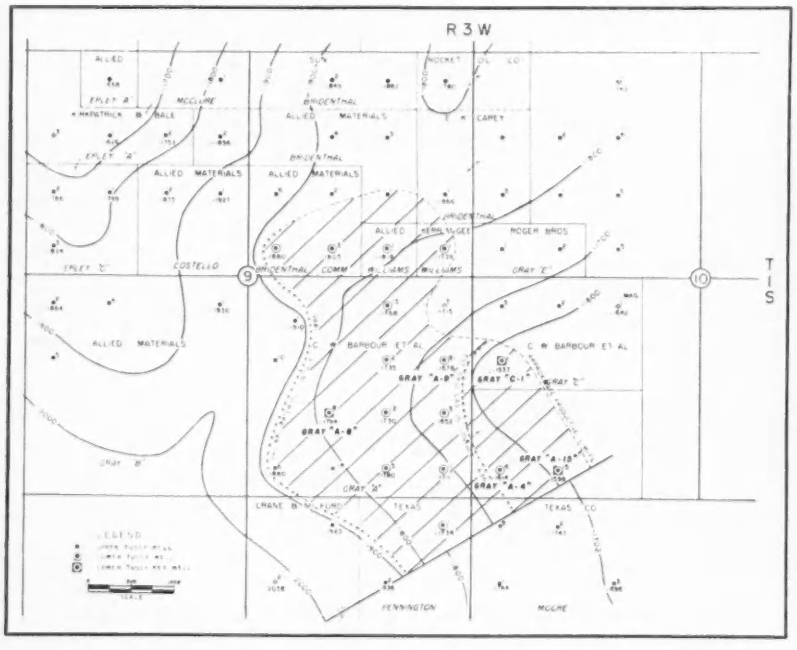

FIGURE 1. Outline of the productive limits of the Lower Tussy sand in the South Tussy area of Carter County, Oklahoma, showing the relationships of the key wells with the producing wells.

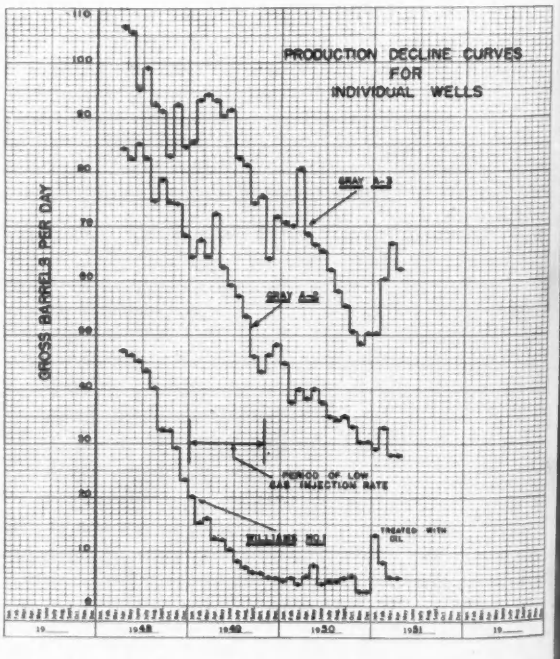

FIGURE 2. Production decline curves for three wells which were completed prior to commencement of pressure maintenance.

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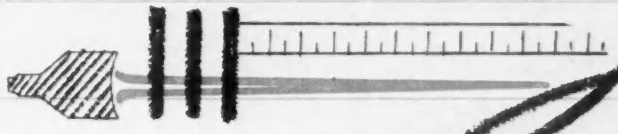

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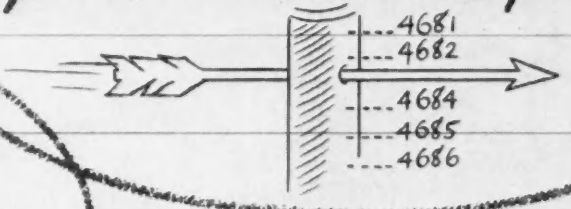

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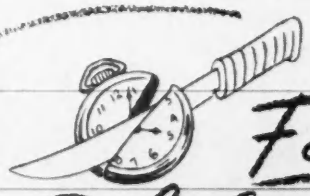

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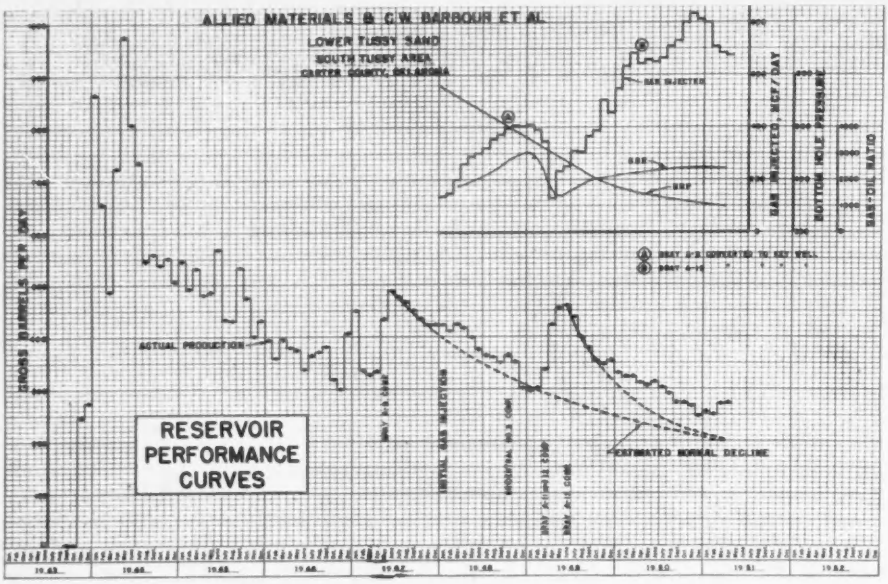

FIGURE 3. Reservoir performance data for the Lower Tussy sand of the South Tussy area. The effect of gas injection on reservoir performance can easily be seen on the gross production curves.

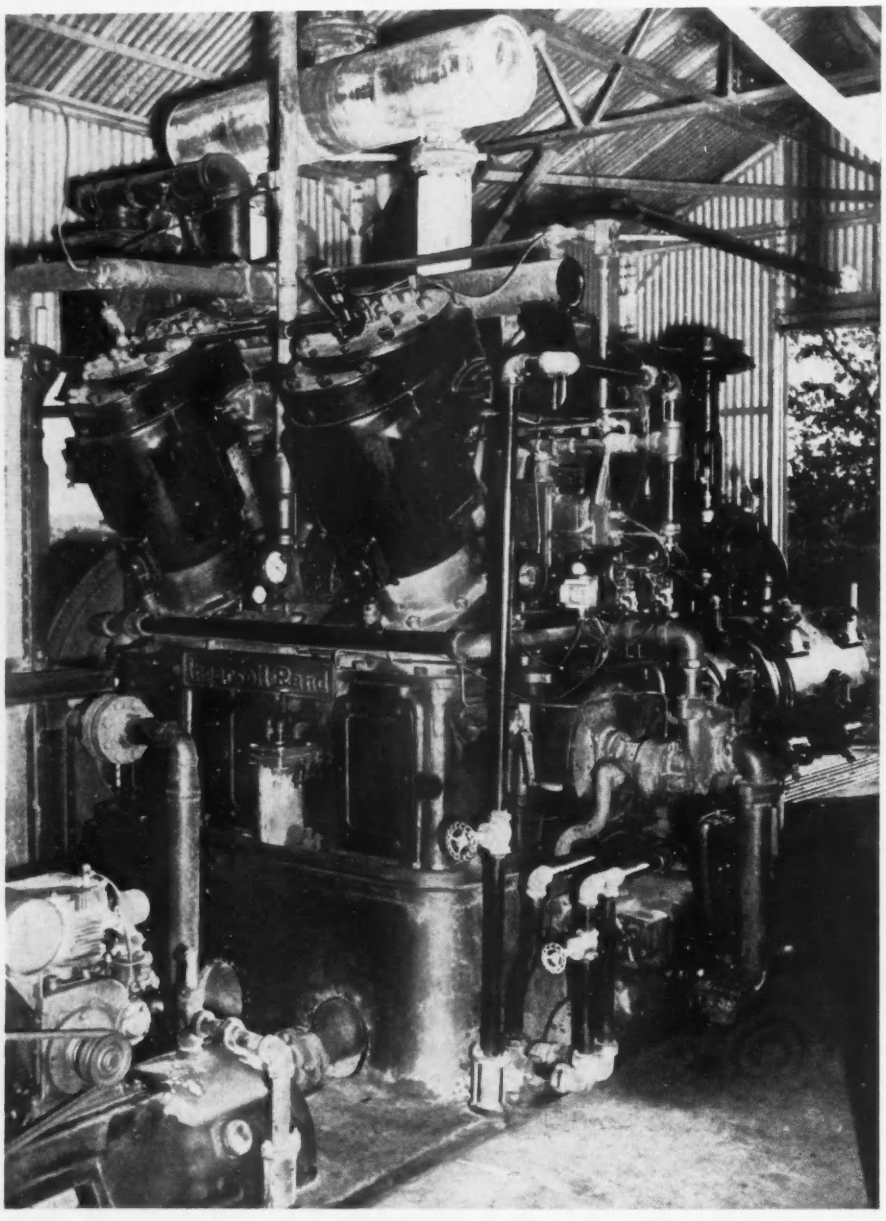

FIGURE 4. Angle-type gas compressor used in pressure maintenance project in the Lower Tussy sand.

the daily production declined rapidly for the following six months; however, this new six-month rate of decline (1949), compared with the previous decline rate (1947), is typical reservoir performance where fill-in locations are drilled. If the reservoir had continued at this rate of decline and without increased gas injection, the decline curve would indicate that additional drilling would have been unnecessary. Economical well spacing is always a complex problem, but it is largely dependent on the viscosity of the oil produced. When the volume of gas injected reaches 500 Mcf per day, the slope of the decline curve changes favorably. As the injected gas volume is increased, the favorable change in the rate of decline becomes more apparent.

Third Key Well

In April, 1950, Gray A-15 was completed in the gas cap of the Lower Tussy sand and was used immediately as a key well. Since the addition of this third key well, the compressor has operated at capacity, and by so doing has aided greatly in the pressure maintenance program. Also, Gray A-15 has made possible the reduction in volume of gas injected into Gray C-1 to 100 Mcf per day, which in turn has reduced the gas-oil ratio in Gray A-9 by one-half. In addition, the volume of gas injected into Gray A-8 was reduced by one-half.

To substantiate further the results of gas injection, Production Decline Curves for individual wells were plotted. These data clearly reveal that the change in the slope of the Lower Tussy sand production curve occurring in November, 1949, was not the result of the development of a high-pressure area in the reservoir. The three wells selected for plotting are wells that were completed before the pressure maintenance was started. Their rates of production and rates of decline made this group of wells easy to compare when plotted on the same graph.

Effects of the changes in the gas injection rate on the oil production decline can readily be seen. All three wells show a decided change in the slope of the decline curve concurrent with the change occurring on the composite curve in November, 1949.

Bottom-Hole Pressure Data

The increased recovery, as indicated by the decline curve, is also verified by the calculated reservoir

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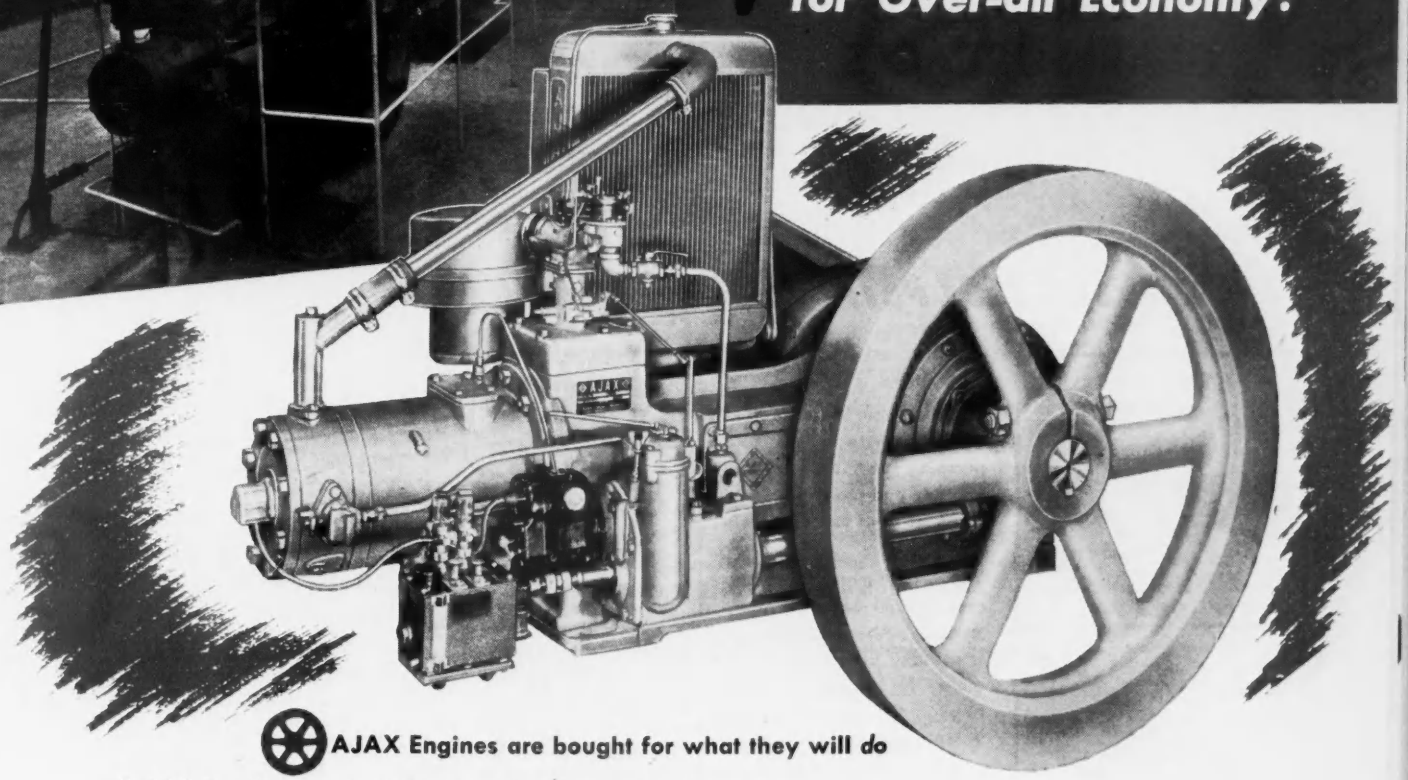

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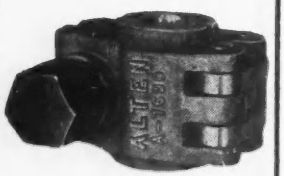

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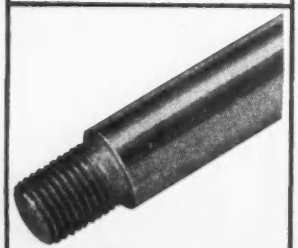

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bottom-hole pressures. The low gravity oil and the fact that rods had to be pulled before bottom-hole pressures could be taken made these tests difficult to obtain. Echo-meter tests proved unsatisfactory because the readings varied extremely with the subsurface pressure gauge readings in this reservoir of low gravity oil. But it was found that bottom-hole pressures taken with a subsurface gauge from January, 1948, to March, 1949, were approximately 100 psig higher than the injection pressure of Gray C-1. This difference in pressure might have been due to the structural location of Gray C-1 and the weight of the gas column in the well. Furthermore, a change in injection volumes ranging from 100 to 500 Mcf per day did not increase the injection pressure. It was considered reasonable, therefore, to use the injection pressure of Gray C-1 to calculate the reservoir bottom-hole pressures at various time intervals. These calculated reservoir pressures also indicate favorable results from pressure maintenance.

Gas-Oil Ratios

The reservoir gas-oil ratios were typical for an expansion gas-cap drive until the fill-in locations were drilled. These newly drilled wells had very low ratios, a condition which retarded the normal expected increases for this type reservoir. Currently the individual gas-oil ratios range from 200 to 6000 cubic feet per barrel, depending largely on the structural location of the well.

Conclusion

The pressure maintenance program has been in operation approximately 3½ years. The Reservoir Performance Curves during the last 1½ years are indicative of favorable results. The most favorable condition has been brought about by the addition of the new key well, Gray A-15, which has permitted input rates to be reduced in both Gray C-1 and Gray A-8.

Expenditures for the pressure maintenance program have been justified and additional recovery therefrom will be substantial. All the increased recovery indicated by the change in the rate of production decline in November, 1949, may not be due to gas injection since a partial water drive is possible from the west flank of the reservoir; however, it seems reasonable that at least a large part of the increase can be attributed to gas injection.

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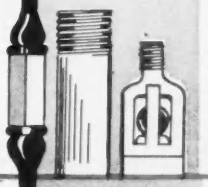
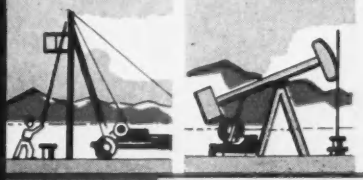


Kontol Corrosion Preventive mixes with the well fluids and adsorbs on the metal surfaces of production equipment as a tough film. This Kontol film prevents attack by corrosive elements, prolonging the useful life of production equipment.

KONTOL ***prevents production stoppages***



By preventing corrosion damage, Kontol helps to keep wells on production. Some wells now treated with Kontol stay on the pump for six months without a shutdown—they formerly were down once a month or oftener.

KONTOL
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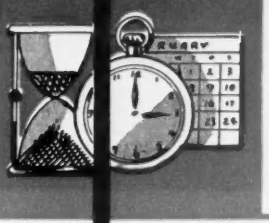

Saving of lease time is the result of the many advantages of Kontol. Of course, keeping the well on production is the most outstanding, but there are many others. Kontol is easy to use, this fact alone is a time-saver. The use of Kontol does not complicate demulsification procedures. Kontol does not deposit precipitates which may plug producing or water disposal formations.

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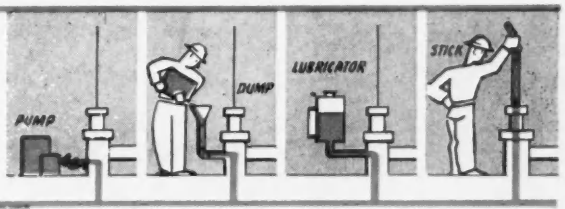
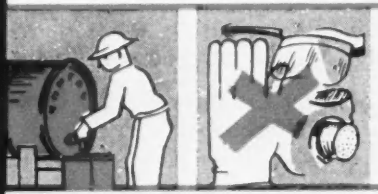


KONTOL
is safe to use



Kontol is non-poisonous, it does not give off offensive or dangerous fumes. No bulky protective equipment such as aprons, gloves, goggles or masks are required in its handling.

KONTOL
does not complicate production routine

Kontol does not cause emulsion difficulties. Emulsified crudes from Kontol-protected wells respond to the usual demulsification procedures. Kontol does not deposit precipitates which may plug producing or water-disposal wells.

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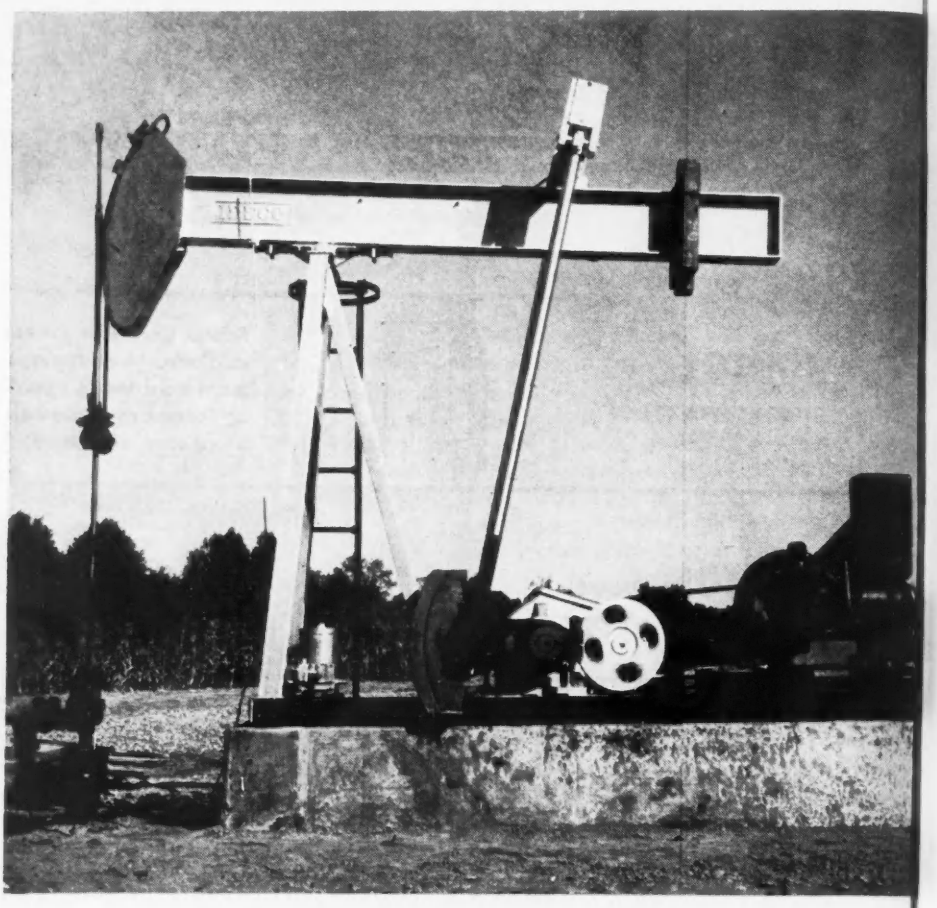

Some Factors Influencing Efficiency

By KENNETH N. MILLS, Mechanical Products Manager
Dresser Equipment Company, IDECO Division
Columbus, Ohio

FACTORS WHICH affect the efficiency of the rod system of oil well pumping are discussed, with particular emphasis on the electrical powered units equipped with speed reducers. The author points out in some detail what determines the power cost for oil well pumping units and suggests how these costs can be reduced. Specifically described are the factors which affect the lifting and over-all efficiencies, which in the end reflect the lifting costs. Factors discussed include friction, slippage, gas compression, evaporation, and electrical losses.

FACTORS influencing the mechanical efficiency of the sucker rod pumping system have not received due consideration because the majority of the wells are pumped with free gas power. Within limits, this lack of consideration of efficiency may be justified, because some of the true losses are intangible. The principal loss in this classification is represented by gas escaping the fluid and reducing the gravity of the oil. This loss is twofold, because it reduces both the volume of oil available for sale and the value of the oil. All losses in the pumping system are important when the well is pumped with electric power, as they add to the lifting costs.

Over-All Efficiency

For purposes of analysis, the over-all efficiency of the system can be defined as the ratio of the theoretical power required to lift the total fluid production from the pumping fluid level to the power delivered to the prime-mover. If the total fluid production represents all water plus the actual quantity of oil delivered to the pipe line, this measure of efficiency includes all surface and subsurface losses.

Due to the limited interest in over-all efficiency, little actual data are available covering the over-all efficiency of the oil well pumping system. The curve marked Over-All Efficiency in Figure 1 indicates how the efficiency of the system varies with depth. This curve is based on data published by Stueve[1] and was obtained from wells pumped with electric power. It is based on rather

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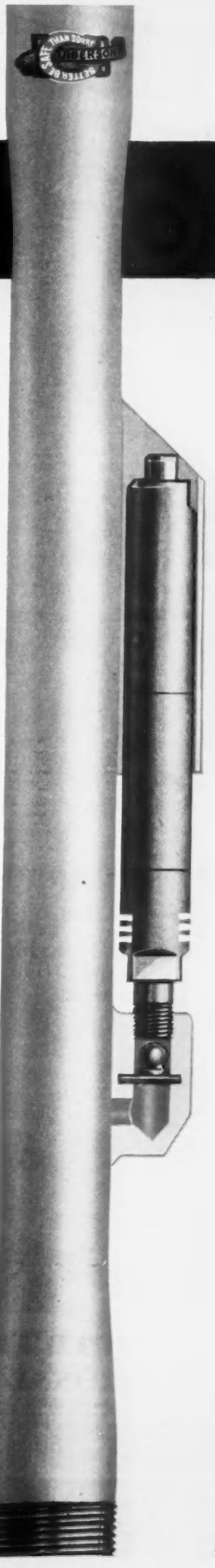

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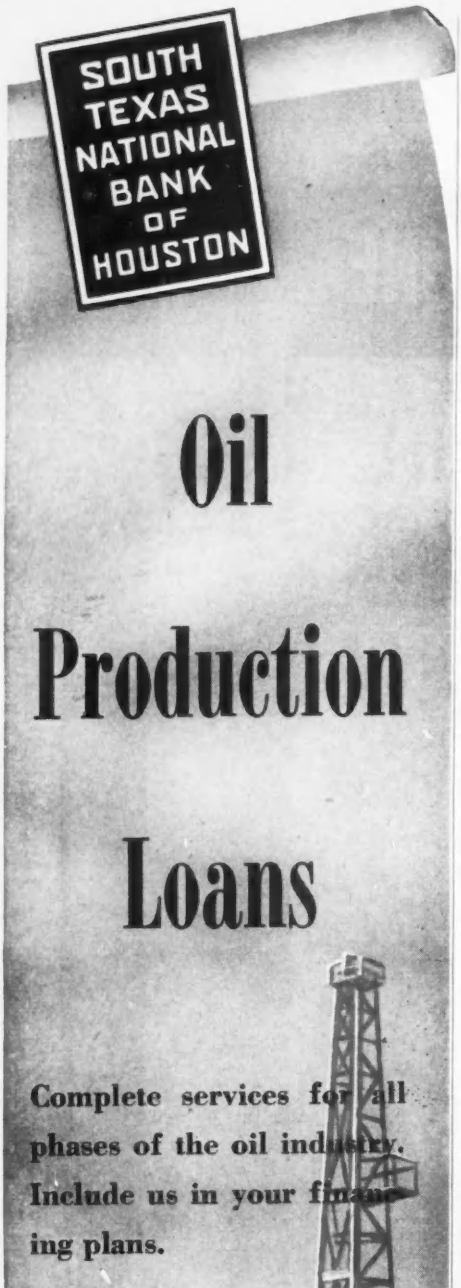
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old equipment and may not be representative of the most modern oil well pumping equipment. However, it does indicate that the over-all efficiency of the system is rather low and possibly could be improved. Also, it indicates that the efficiency varies with well depth.

In general, power losses in the oil well pumping system can be classified as: friction; slippage; gas compression; evaporation; and electrical.

The friction losses occur in the following points: pump; between rods and tubing; stuffing box; fluid friction in pump, tubing and lead lines; pumping unit and drive; and prime-mover.

Slippage and gas compression losses all occur in the pump. These losses can be reduced by proper pump selection and efficient gas anchor design. The evaporation losses occur in the surface storage equipment and can be kept at a minimum through proper equipment selection and good operating practices. The electrical losses only exist when electric power is used, and they occur in the motor and power transmission system. These losses can be controlled by proper equipment selection and periodic load analysis to assure near capacity utilization of the electric motors.

Lift Efficiency

The curve labeled Lift Efficiency in Figure 1 is the ratio of the hydraulic horsepower to the polished rod horsepower, and it is a measure of the efficiency of the subsurface system. This curve is based on data collected by Kemler & Hosford.[2] The general characteristics of this curve indicate that the major portion of the subsurface losses occur in the pump and are the results of slippage, friction and underfilling. This thought is based on the fact that the lift efficiency varies with depth and reaches a peak value which occurs at approximately 2800 feet. If the pump friction losses are constant and do not vary with depth, the efficiency of the lifting system should increase as the depth increases, because the total lifting horsepower is increasing. This probably accounts for the gradual increase in lift efficiency up to the 2800-foot depth. Opposing this effect, the pump slippage and gas compression losses increase as the depth increases. Also, the stroke loss due to

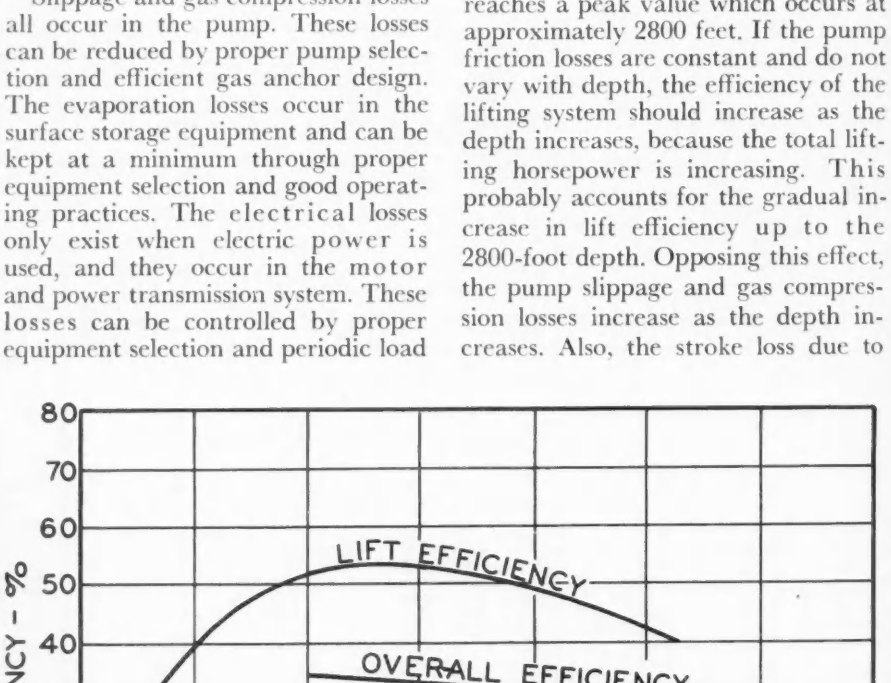


FIGURE 1.

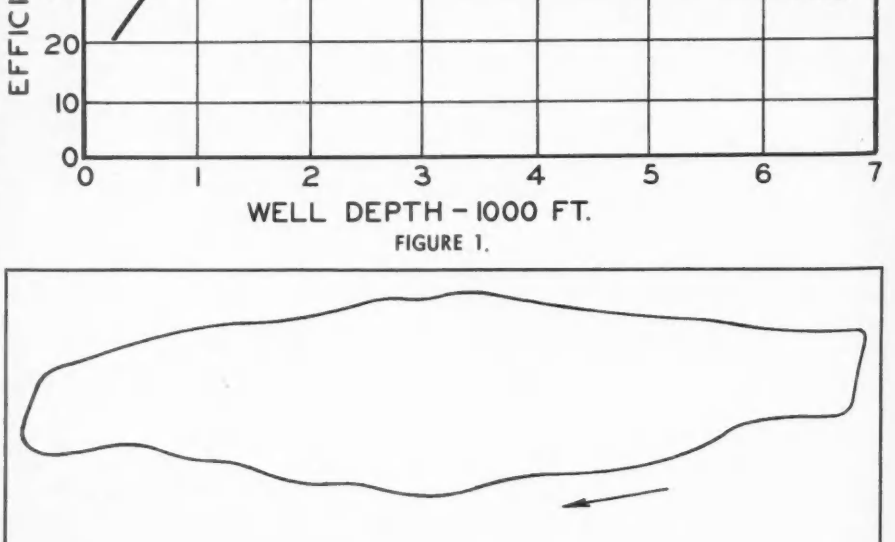


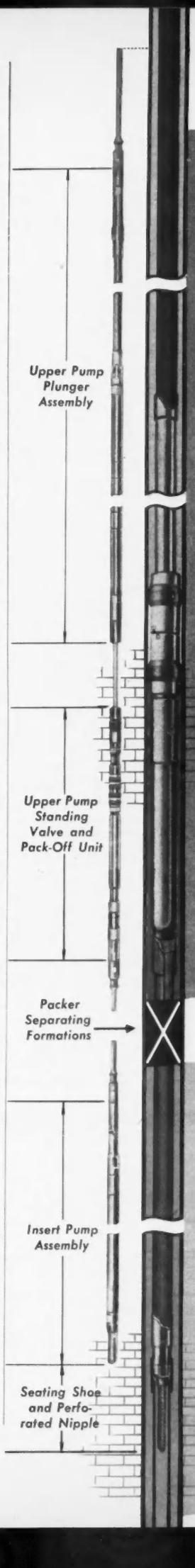
FIGURE 2.

rod and tubing stretch increase and the increased polished rod stroke required to compensate for this loss increases the friction losses in the sucker rod string. These increased losses probably account for the drop in efficiency, as the pumping depth is increased beyond 2800 feet.

Friction Losses

The friction losses in the pump are the results of mechanical friction between the pump plunger and the working barrel and fluid friction in the gas anchor and the valves. The magnitude of the mechanical losses are dependent on the type of plunger, the fit of the plunger in the barrel, and the nature of the fluid being produced. If the plunger is fitted with common cups, excessive friction can result from the use of cups which are too soft for the imposed fluid loads. In this case the fluid pressure will distort the cups and tend to extrude them through the space between the plunger and the barrel. This action will increase the friction forces between the cups and the barrel. If the pump is fitted with a ring-type plunger, excessive friction will exist if the fit between the rings and the barrel is excessively tight. The minimum plunger friction will be obtained when a properly selected metallic plunger is used, because in this case the plunger is not in mechanical contact with the barrel, as the seal is produced by the oil film between the plunger and the barrel. To assure minimum friction and slippage, the clearance between the plunger and barrel must be chosen to prevent the entrance of sand particles which can materially increase the friction losses in the pump.

Fluid friction losses in the gas anchor and standing valve assembly reduce the effective submergence of the pump and, therefore, reduce its mechanical efficiency. Also, the pressure drop created by these friction losses may reduce the volumetric efficiency of the pump, because it will promote the liberation of free gas inside the pump. If gas is liberated inside of the pump, it will occupy a portion of the displacement volume of the pump and decrease its volumetric efficiency. The gas entrapped in the pump must be compressed to tubing pressure before the traveling valve will open, and some energy is required to compress this gas. Some of the energy used to compress the gas is converted to heat, and the major portion of this energy is lost to the formation. The remaining energy will be returned to the system as expansive lifting force. The energy lost through this gas compression process


Upper Pump Plunger Assembly
Upper Pump Standing Valve and Pack-Off Unit
Packer Separating Formations
Insert Pump Assembly
Seating Shoe and Perforated Nipple

THE OTIS TWO-ZONE PUMP for dually-completed wells is an assembly of two sub-surface pumps which operate simultaneously on a single sucker rod string. The pumps work in conjunction with a pack-off unit in a special cross-over packer to produce the upper zone through the tubing and the lower zone separately through the tubing-casing annulus. The pump assembly illustrated (Type C) consists of a tubing pump to produce the upper zone and a rod (insert) pump for the lower zone. Both formations are pumped in the conventional manner, the same as in a single-zone well, and at no time do the fluids commingle. Operation of the second pump does not require an additional pumping unit, stuffing box, polished rod, or special surface fittings, nor does it increase the rod and engine load appreciably.

Pumping two-zone wells with this equipment is practicable and profitable because there are no complex production principles or costly maintenance problems. During the past few years, a large number of these pump assemblies have been installed in many different types of dually-completed wells throughout the Mid-Continent area.

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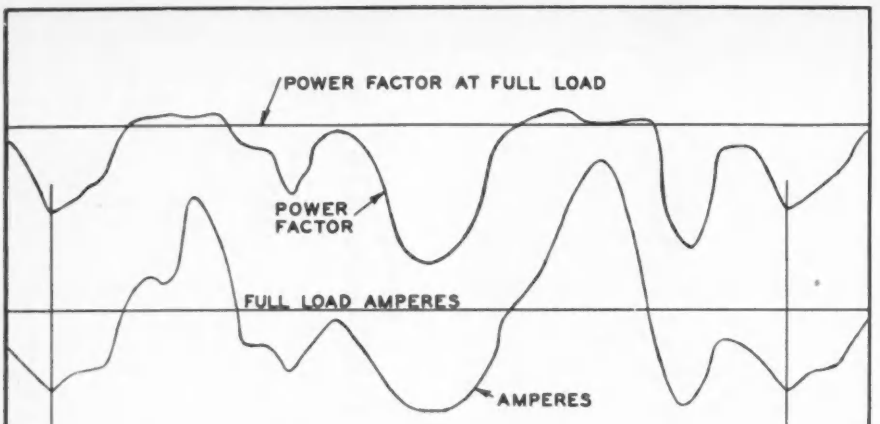

FIGURE 3.

is small compared to the additional losses resulting from the reduced pump volumetric efficiency. The reduced volumetric efficiency increases the number of stroke cycles required to lift a given quantity of fluid, and this increases the magnitude of the total power loss, as these losses are dependent on the number of stroke cycles. Therefore the over-all efficiency of the system is dependent on the volumetric efficiency of the pump.

Gas Anchor

The pressure drop in the gas anchor is a function of the fluid velocity in the gas anchor and the length of the gas anchor pipe. The pressure drop increases as the fluid velocity and pipe length is increased. The importance of gas anchor pipe size is illustrated by Table 1, which was compiled by Chenault.[3] This table is based on pumping a 54-inch stroke, 20 strokes per minute and a ten-foot long pipe.

The table indicates that minimum losses on the suction side of the pump will be achieved when the pump is fitted with an oversized gas anchor pipe. An additional reduction in these losses can be achieved by using the largest possible standing valve assembly, as a small standing valve will create a restriction on the suction side of the pump which will reduce its efficiency.

The adverse effects of gas on the volumetric efficiency of the pump can be reduced by using a pump designed to give a high compression ratio and properly spacing the pump. Considering a given pump size, the maximum compression ratio is obtained, when the pump plunger is fitted with a valve on its lower end, and the traveling and standing valves are spaced close together on the lower end of the stroke. The compression ratio is also affected by the plunger diameter and stroke length. Increasing either the plunger diameter or the stroke length will increase the efficiency of the pump when handling gaseous fluids.

TABLE 1

	Regular Anchor		Oversize Anchor		
Pump Size	Pipe Size	Pressure Drop psi.	Pipe Size	Pressure Drop psi.	Percent Decrease In Pressure Drop
1¾"	¾"	21.2	1¼"	2.3	89
2¼"	1"	16.7	1½"	2.4	86
2¾"	1½"	4.5	2"	1.3	71

Slippage losses are direct power losses, because it requires the same amount of power to lift the plunger with 90 percent of the fluid slipping past the plunger during the lift stroke, as is required with 1 percent or less slippage. The magnitude of the slippage losses is dependent on the type of pump, the condition of the pump, and the viscosity characteristics of the well fluid. Considering a given type and size of pump and well fluid, the slippage losses will increase directly with well depth, because they are dependent on the differential pressure at the pump plunger. In the case of pumps fitted with metallic plungers, the slippage will increase with the cube of the plunger clearance. This would indicate that closely fit plungers are desirable when well conditions will permit their use. As the pump must operate under the temperature and pressure conditions existing at the bottom of the hole, these conditions must be considered when selecting the pump. If the materials used in the pump plunger and barrel have different co-efficient of thermal expansion, the plunger clearance will be affected by bottom-hole temperature. This possibility should be considered when the pump is selected because it may affect pump efficiency and life. Location of the pump hold-down can alter the effective clearance in the pump. If a stationary tube pump is fitted with a top hold-down, the outside of the pump barrel is exposed to fluid at a low pressure, and the inside of the barrel is partially exposed to fluid at a high pressure. This differential pressure tends to expand the barrel and increase the clearance. If the pump is fitted with a lower hold-down, the

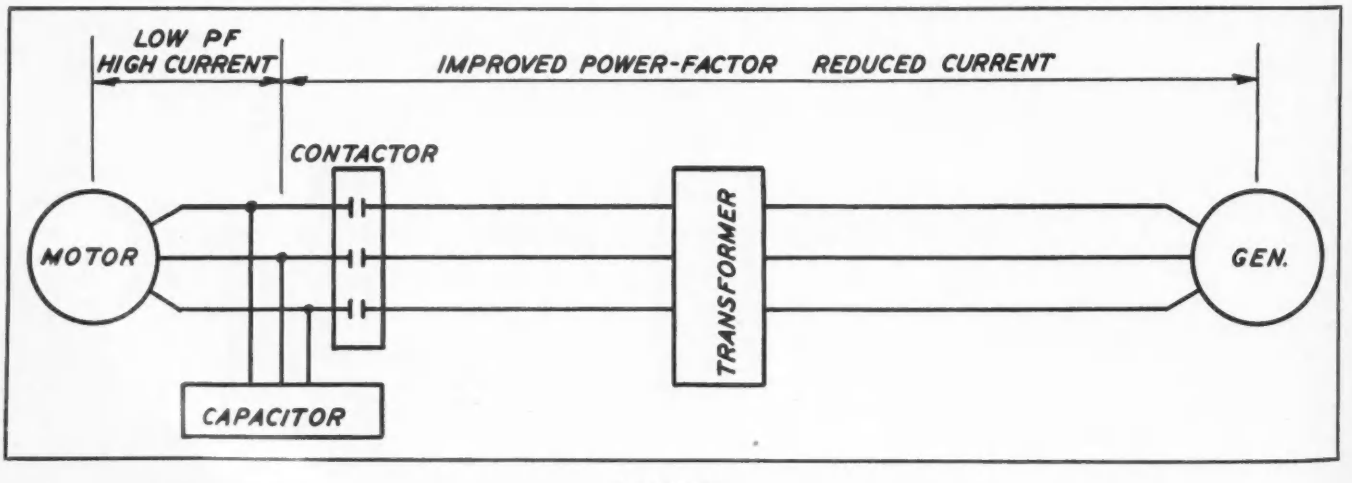

FIGURE 4.

outside of the barrel is exposed to high pressure fluid and the tendency of the fluid pressure to expand the barrel and increase slippage is eliminated.

The amount of slippage experienced with cup and ring type plungers depends on the condition of the cups or rings, and the performance of these seals during the first few hours of operation. If the cups are not damaged during installation and do not leak during the "breakin" period, they will form a tight seal and operate with negligible slippage until they are completely worn out. If they start leaking during the "breakin" period, they may become "fluid-cut" and will not form an effective seal.

The magnitude of the friction losses between the tubing and sucker rods is dependent on the straightness of the hole and the cleanliness of the tubing. If the hole is crooked, excessive friction will exist betwen the rods and tubing, and little can be done to eliminate this power loss. A similar loss can be created by an improperly set tubing anchor. If the tubing anchor is set too high and places the tubing in compression it will "cork-screw" and increase the friction between the rods and tubing. The existence of this condition can be detected by a dynamometer study of the well because it will create excessive polished rod loads. Excessive sucker rod friction losses can be created by heavy paraffin deposits in the tubing. Losses of this type can be reduced through the use of paraffin removal equipment.

Stuffing Box Important

Fagg[4] has presented data indicating that relatively large friction losses can be created by excessively tight stuffing boxes. The dynamometer card shown in Figure 2 was published by Fagg, and it illustrates the results of an excessively tight stuffing box. The polished rod load with the tight stuffing box was 11,000 pounds and this load was reduced to 10,500 pounds by loosening the stuffing box.

The exact efficiency of the pumping unit is not known. It is reasonable to expect the mechanical efficiency of the modern pumping unit to be betwen 85 and 90 percent. This value is partially based on measured efficiencies of all roller bearing geared speed reducers. The measured efficiency of this portion of the pumping unit was 97 percent when operating at full load and 20 spm. The friction loss in the structural portion of the pumping unit should depend on the type of rig bearings and should be high when modern oil sealed bearings are used.

Electrical Pumping

The operating efficiency of electric motors used in oil well pumping will depend on the ratio of the applied load to the rated load capacity of the motor and type of motor. To assure reasonable power costs, the motor size should be such that it will be loaded near its rated capacity. This condition should give the best possible motor efficiency for a given type motor. Also, it will assure the maximum power factor obtainable without capacitors, and thereby, keep the lease distribution losses at a minimum. Due to the large number of variables in oil well pumping, the exact motor loads cannot be calculated and must be determined by measuring the input power to the motor. As changing well conditions will influence the power requirements of individual wells, maximum efficiency can only be assured by making individual well power surveys and transferring motors to keep the motors loaded near their rated capacity.

The over-all efficiency of an oil well pumping installation is influenced by the type of motor used to drive the pumping unit. Field tests on pumping installations indicate that the efficiency of the high-slip motor is slightly higher than that of the normal-slip motor. Also, losses in

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the lease distribution system are less with high-slip motors because the peak current demands are less and the power factor is higher. These advantages of high-slip motors are illustrated by the data shown in Table 2. These data were obtained during a series of tests[5] on a West Texas well.

In addition to having better electrical characteristics for oil well pumping, the high-slip motor has better mechanical characteristics. It imposes lower peak torque loads on the reducer because it tends to shirk the peak loads and permit the rotating inertia of the system to give up energy to carry these peak loads. As the principal rotating inertia is in the crank, this portion of the energy required to carry the unit through the peak torque point is not imposed on the speed reducer. It has better starting characteristics and will permit operating the motor nearer its rated capacity.

The power losses in the lease distribution system are influenced by the power factor of the motors and will decrease as the power factor is increased toward unity. The average power factor for a pumping installation is relatively low due to the cyclic nature of the load. The cyclic motor loads range from a peak which probably exceeds the name plate rating of the motor to a low value of approximately zero load. The low power factor prevailing during the periods of low load keeps the average power factor for the installation lower than the normal power factor for the motor. This effect is illustrated by the data shown in Figure 3 which was published by Lamberger and Swindell.[6] The power factor can be improved by installing capacitors on the line. To obtain the maximum benefit from the capacitors, they should be installed at the motor. The correct location is illustrated in Figure 4. When they are installed in this manner they improve the voltage conditions at the motor and reduce the power losses in the line by reducing the current in the line.

As the majority of the losses in the pumping system are incident to the pumping motion and are not dependent on producing fluid, it is desirable to stop the pumping action when the well is pumped off. If the pumping motion is not stopped, the power loss which occurs when the well is pumped off will materially add to the cost of power. For maximum efficiency the pumping unit should be shut down when the well starts to pound fluid, because when this condition occurs the pumping efficiency starts to drop rapidly. Also, pounding fluid is detrimental to both subsurface and surface pumping equipment.

TABLE 2

MOTOR TYPE	Normal-Slip	High-Slip
Line Voltage	484	492
Max. Current Amps.	12.7	6.4
Min. Current Amps.	10.3	3.8
Max. Power Factor, Percent	50.7	81.8
Min. Power Factor, Percent	31.5	76.0
Max. Power Input KW	5.2	3.8
Min. Power Input KW	2.0	2.0
Average Power Input KW	3.6	3.1
Pumping Speed SPM	16	16.5

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[1] Electric Power Required For Pumping Oil Wells, W. H. Stueve, Petroleum Engineer, Sept. 1937.

[2] Typical Dynamometer Cards & Their Application, E. Hosford & E. Kemler, API Drilling & Production Practice, 1940.

[3] Selection & Use Of Sucker Rod Pumps, R. L. Chenault, Presented to ASME, 1947 National Conference On Petroleum Mechanical Engineering.

[4] Dynamometer Cards & Well Weighing, L. W. Fagg, Presented to AIME at San Antonio, Oct. 5, 1949.

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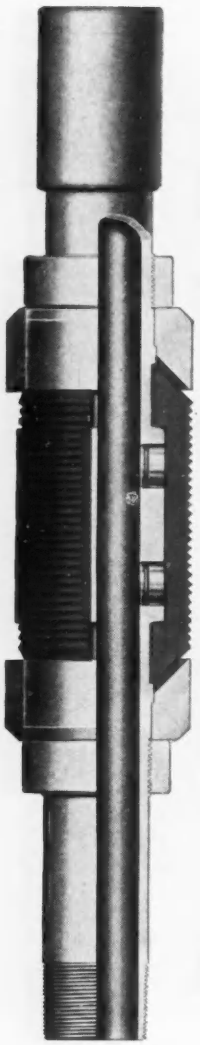
[6] Power Factor Correction On A Pumping Lease, E. H. Lamberger & R. A. Swendell, The Oil And Gas Journal, Feb. 9, 1950.



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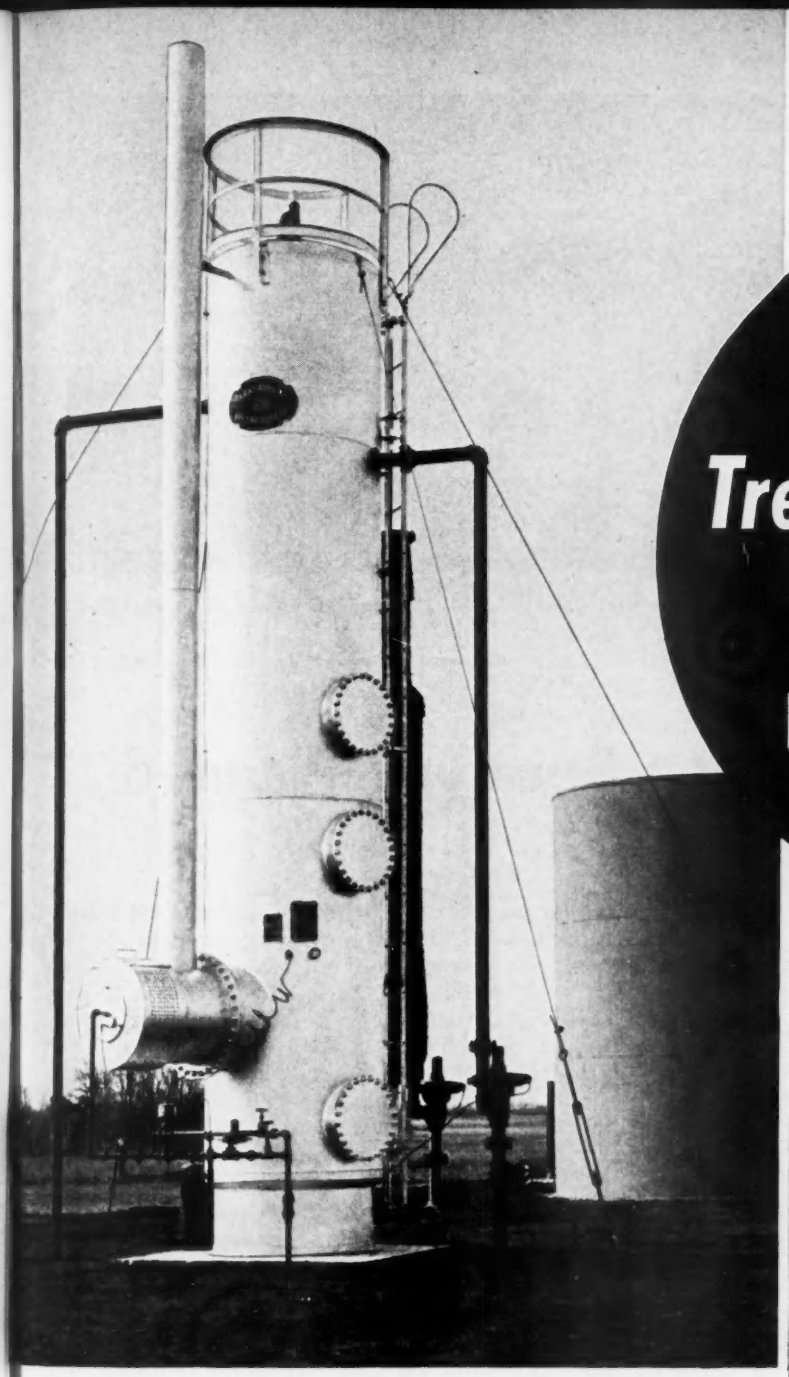

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Artist's conception of what the project will look like after Oak Creek Reservoir is filled with water.

Wellheads Raised When Reservoir Planned

A RESERVOIR planned to supply Sweetwater, Texas, with adequate fresh water, would have placed three of Humble Oil & Refining Company's producing wells in the Fort Chadbourne field of eastern Coke County below the anticipated water level of a 4000-acre lake. With a considerable backlog of experience in offshore drilling and producing wells in the submerged marshes along the Gulf Coast, Humble found a quick and satisfactory solution by employing a large caisson surrounding the well and extending the casing so that wellhead equipment would be above the projected water level.

This unique problem, essentially one to be coped with by those familiar with marine operations, was brought about by a developing water shortage in Sweetwater, where municipal wells could not furnish the needed water during the drouth season. Winding through the Fort Chadbourne field was almost a dry creek bed, at the bottom of which Oak Creek flowed seasonally. Being the nearest possible source of additional water for Sweetwater, plans were made to construct a large reservoir from which it is proposed to pump about 6 million gallons daily into Sweetwater.

The projected water level of this man-made lake would place three of Humble's wells, located near the edge of this creek bed, below the lake's level. To cope with this problem before the dam was finished, and during a time when the presence of water would not interfere with the operation, all three wells were elevated as high as 16 feet above their original settings. One had to be raised only ten feet.

Typical Task

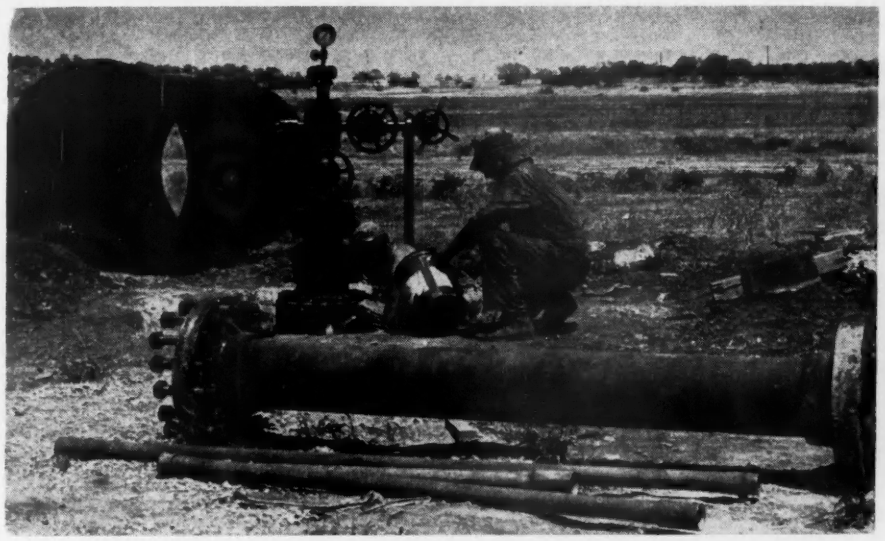
Two of the three wells involved were flowing wells, these being the Sallie Odom 8 and Sallie Odom 4. The third well, Odom State 1, was a pumper. The procedure involved was essentially killing the well, setting the caisson, extending the casing and tubing, and building a large mound of earth around the well.

The Sallie Odom 8 was 400 feet east of Highway 70 and bottomed near 5300 feet. The well was killed by pumping 200 barrels of water into the tubing and filling the casing annulus. A little more than 140 barrels went into the 5½-inch casing and the two-inch tubing. The remainder seeped into the oil sands. With the well dormant, the christmas tree was removed and the caisson set in place. Measuring five feet in diameter and 16 feet long, the caisson weighed about 3000 pounds. A special concrete foundation was poured around the wellhead so the caisson could be bolted in place.

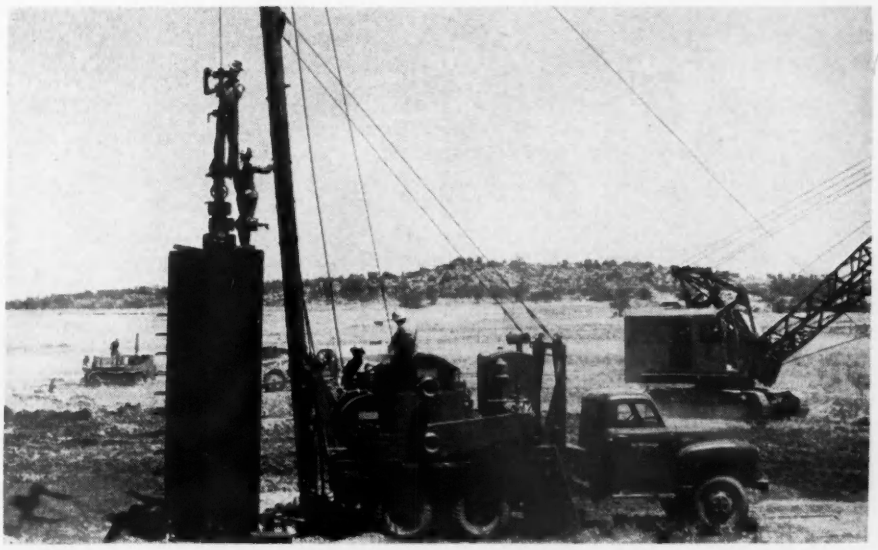
A 16-foot casing spool, flanged at both ends, was bolted over the surface casing flange, and a similar length of two-inch tubing screwed in place. The original christmas tree was then bolted in place so that the entire assembly was elevated 16 feet above the first setting. The caisson as well as the exterior of all equipment placed inside it were doped to prevent corrosion. Ladder rungs were welded to the inside and outside of the caisson so that workmen could climb into the enclosure to make the necessary connections. The two-inch flow line also extended inside the protective caisson and was connected to the original flow line which carried production to tank batteries on a hillside overlooking the proposed Oak Creek reservoir.

A portable mast and swabbing unit were brought in and the water cushion which formed the hydrostatic head was swabbed out. After about four hours of swabbing, the well began to flow under its own pressure and was turned into the tank battery.

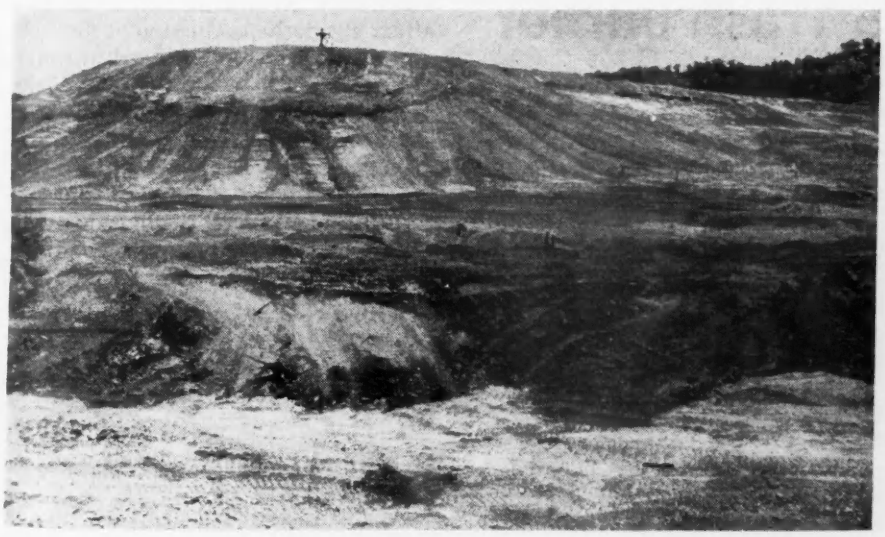
Meantime, earth-moving equipment carried large quantities of dirt up to the wellhead and a large mound was made around the well. The gap between the upper edge of the creek bed and the well was filled in for a roadway. This stone-reinforced ramp will bulge into a 200-foot circle around No. 8, providing ample room for future work over rigs to operate should any additional work become necessary. In the not-too-distant-future, motorists driving along Highway 70 between Sweetwater and San Angelo, Texas, will witness this man-made spectacle of earth-bound water, and will also see the relatively small "mesas" fingering into the lake, and on each mesa they may view a familiar oil field sight . . . a modern christmas tree. *(Article adapted from Humble* Way, *which also furnished illustrations.)*



Workmen dope well head equipment prior to setting the large caisson (shown in background) over the well. Tubing pup joints and flanged casing spool await installation.



The caisson has been installed, the well elevated, and workmen are shown here swabbing the hydrostatic water head from the well.



This is how the Sallie Odom 8 looks from the creek bed after the mound of earth had been placed around the caisson and leveled off at the new wellhead height.

4 HELPFUL FACTS on well pumping efficiency

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HOW TO—Connect Bypass for Individual Well Testing

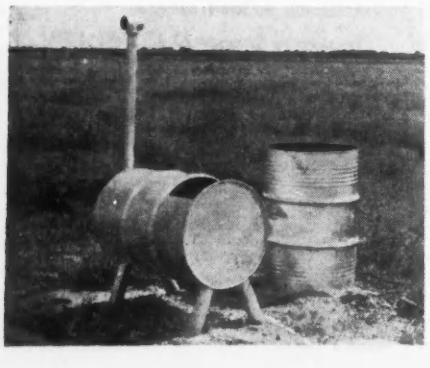
Where periodic gas-oil ratio and production tests on oil wells are necessary, this simple method of connecting a portable separator may be helpful. Illustrated is part of the flow wing of a christmas tree, where the oil flow from the wellhead through the horizontal line at the left, and downward through the two-inch flow line leading into the ground and into the separators.

When the well is to be placed on test by using a portable test unit, the bull plugs on the two four-way fittings in this vertical flow line are removed. A blank flow bean is carried with the mobile testing unit, and the blank is inserted in the vertical line in place of the flow bean used to regulate the flow of oil and gas. The flow bean removed from the vertical flow line is then placed inside the flow nipple attached to the four-way cross shown at the operator's elbow in the illustration at right. In this manner, the production is flowed through the well checker and back into the normal flow line which is connected to the checker through the bottom four-way cross. Fluids are flowed through the same choke normally used on the well. The blank bean causes the fluid to be shunted through the portable tester, and back into the flow line leading to the regular separators.

If for any reason the choke bean has been slightly sand cut, it will not affect the daily production of the well. since the well is produced through the same choke as that on which the test is made. The only modification necessary is that two four-way crosses be installed on either side of the choke in the flow wing of the line, and two swage nipples be fabricated to fit into the open connections of these four-way crosses. The upper swage nipple is equipped with an adapter inside to accept the flow bean. The lower swage is of conventional construction. The illustration at left shows the installation of the upper swage which contains the regular well flow bean. while the right hand photo shows the operator inserting a blank bean back into the regular seat between the two four-way cross connections.

HOW TO—Make Camp Trash Burner

Instead of using a metal drum in an upright position as a trash burner as shown at right, a modification was made to improve the use of the handy device. Instead of setting the drum on end, it was mounted horizontally on four legs welded to the drum as shown. A four-foot stack of four-inch pipe, with a tee screwed on the end, was welded to the top end of the burner.



A rectangular opening was cut in the top of the drum so that trash could be dumped inside for burning. Holes were perforated in the bottom of the drum so that rain water falling through the opening would pass on through; and too, the holes add to the draft made possible by the extended stack.

Two advantages are claimed for this simple arrangement: (1) trash can be burned even in the rain, and (2) burned paper, or paper still on fire, is not likely to be blown away.

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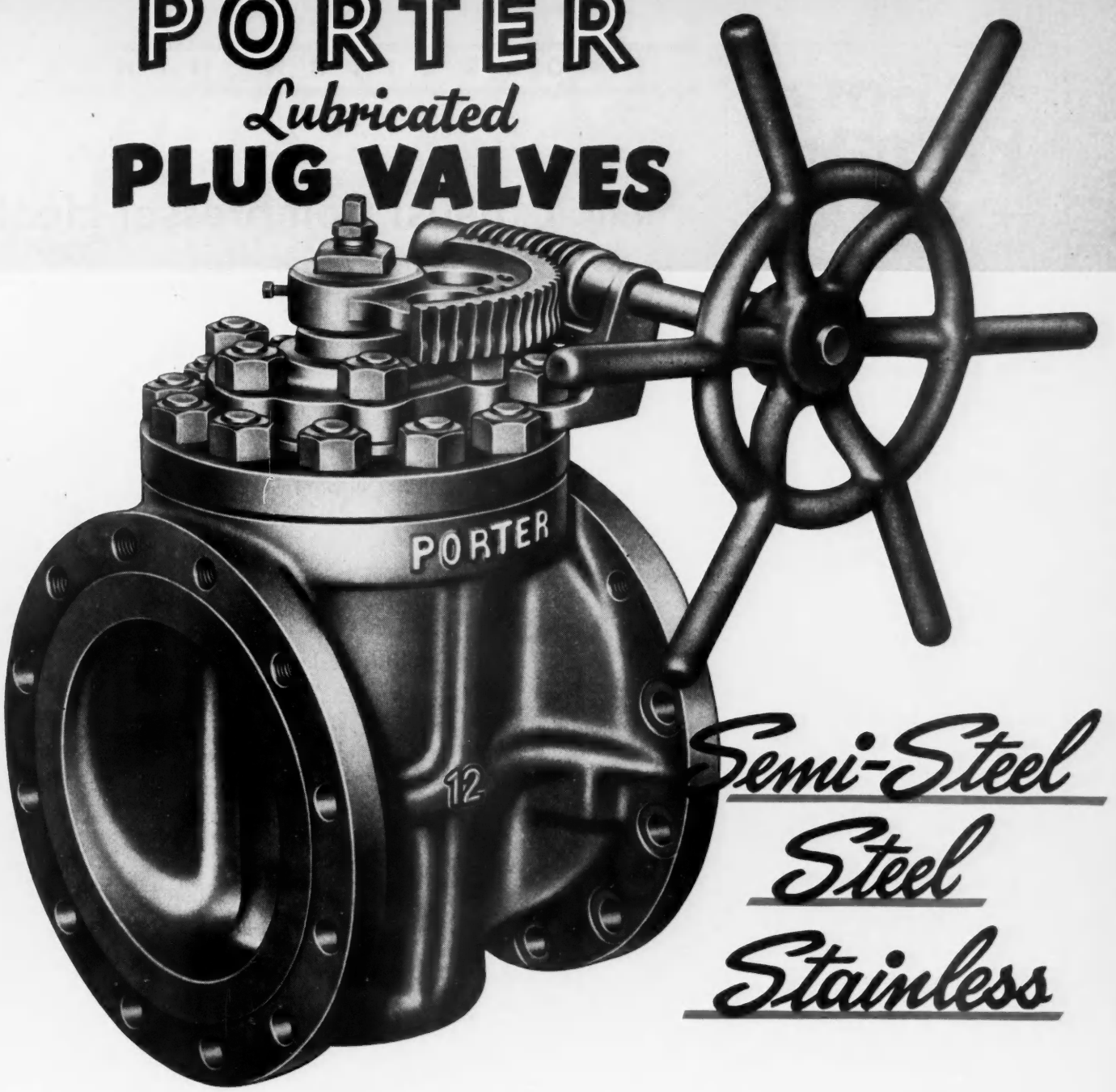

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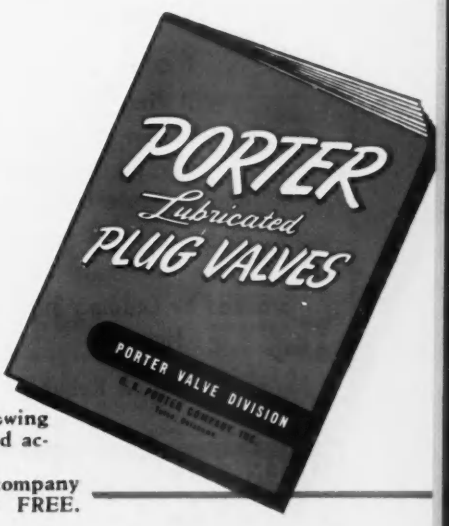

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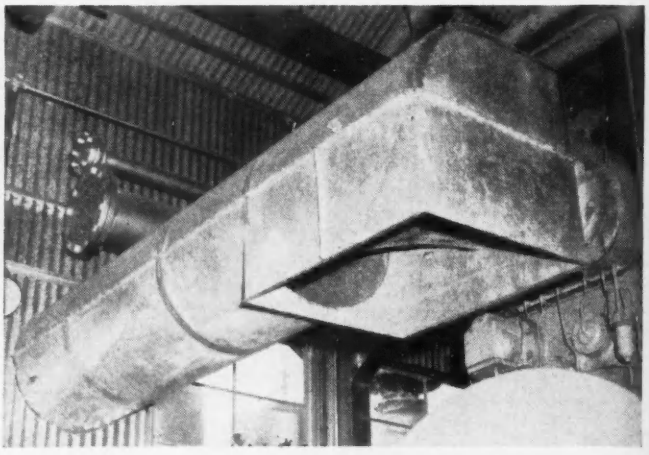
HOW TO—Exhaust Compressor Heat



Adequate ventilation is a prime consideration in designing compressor buildings for pressure maintenance plants. During winter months, there is little if any difficulty in maintaining a warm interior; however, during hot months, temperatures inside large compressor buildings may reach more than 100° F. unless adequate ventilation has been provided. Sources of heat inside the building, and perhaps the largest contributors to unwanted heat, are the large engine exhaust lines leading from the engine to the exhaust silencers outside the building.

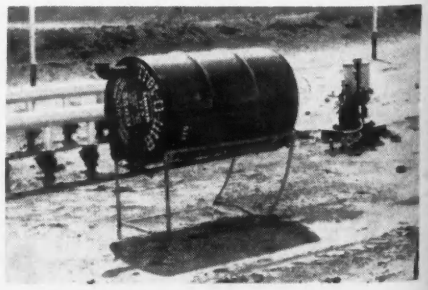
While it has been only recently that this problem has been considered seriously by designers and constructors, some relief has resulted from a special venting device fabricated for each installation. Ventilation of heat from this exhaust line is accomplished by a normal draft resulting from a short stack and sheet metal housing placed around the hot pipe. Illustrated is the interior of one station that utilizes this principle. In this case, the exhaust line is 13 inches in diameter, and a 20-inch galvanized sheet metal housing is assembled around the line as shown.

At the 90-degree elbow of the exhaust line is a large rectangular opening so that air from the inside of the building can flow through the annulus between the exhaust line and the housing, and in this manner carry the excess heat out the stack on the side of the building.

The section of the sheet metal housing outside the building is closed in around the exhaust line and a hole cut in the upper side so that a similar sized stack could be attached. By elevating the stack about 12 feet above the exhaust line, a natural draft is created due to the heat from the line, so that the unwanted heat can be carried out of the building. This device requires no maintenance whatsoever.

HOW TO—Handle Chemical Drums

One joint of salvaged three-quarter-inch sucker rod was all that was required to construct this chemical drum dispensing rack. A simple job of welding and bending did the trick. The frame rack is slightly longer than the standard size drum, and is made to support the drum about two feet off the ground. It is essentially box-shaped, with one pair of end pieces bent so the drum can be lowered from a vertical position to horizontal. Two curved pieces of rod material form the cradle which holds the drum in place. It is light enough to be moved or hauled by one man when not in use. Chemicals can be easily dispensed from the drum when it is elevated in the position shown.



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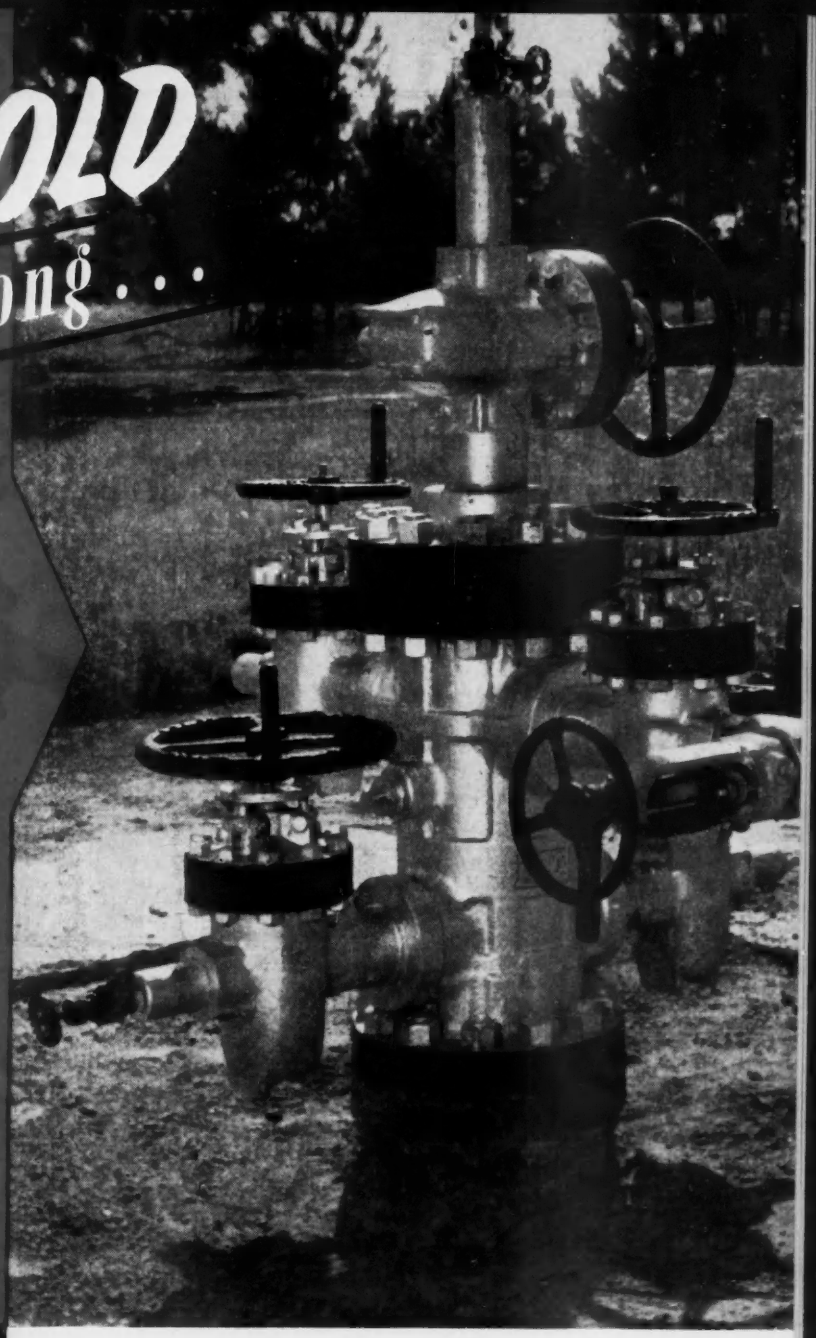

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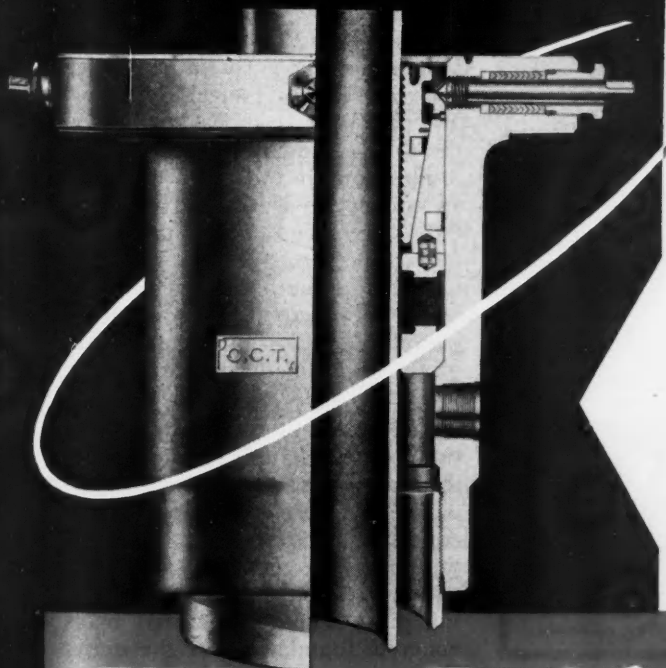

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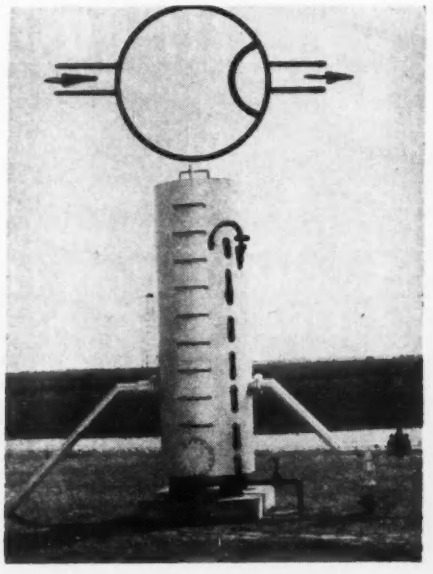
HOW TO—Construct Simple Gas Scrubber for Field

Where the flow of gas is not too great, a simple scrubber can be fabricated in the welding shop to knock out free water, distillate and foreign matter before the gas is measured. Here is a field installation of such a scrubbing unit that has proved satisfactory.

The eighth-inch plate steel was rolled and welded together to form a cylinder about two feet in diameter and six feet long. A four-foot section of ten-inch casing was cut longitudinally so that slightly less than half of it was used. This section was welded inside the vessel so that one end was flush with the bottom, while the other end remained open and about two feet from the top. Both ends of the vessel were welded closed. Connections were added to the bottom for a liquid drain line, a small collar added to the top to accommodate a pop valve, and both inlet and outlet openings were provided on opposite sides of the scrubber as shown in the diagrammatic cross section directly above the side view of the unit.



Gas, flowing in from the left, encounters a relatively large volume and its velocity is considerably reduced. Escape from the vessel is over the top of the casing section welded inside the unit and down to the outlet connection leading to the metering section. Liquids and foreign matter released from the gas stream are collected in the bottom of the scrubber from which they can be drained periodically by opening the gate valve on the drain line leading to the burning pit.

Ladder rungs welded to the outside of the scrubber as shown afford a means of checking the pop valve to insure its proper working condition. The scrubber is mounted on four short sections of I-beam steel equipped with six-inch square footing pads. These legs rested upon a concrete foundation for the unit.

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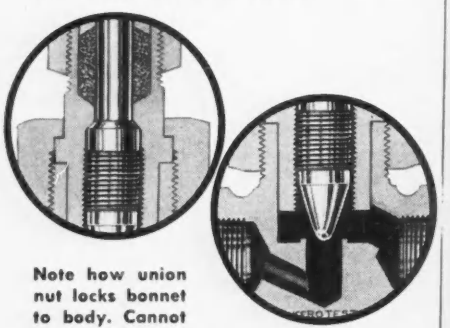

Note how union nut locks bonnet to body. Cannot back off. Assures safe repacking under pressure. Stem back seats for safety. Conical stem tip provides micrometer throttling action and positive seal.

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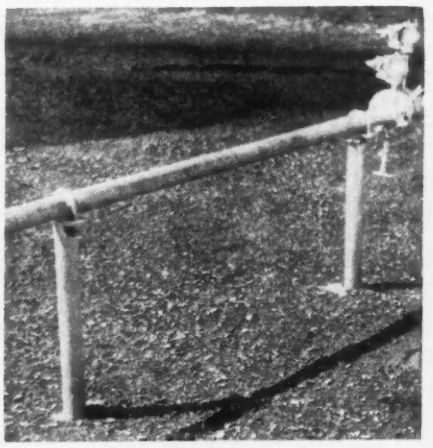
HOW TO—Support Elevated Lines

For convenience, gas flow lines leading to metering stations are usually elevated to about 28 inches above ground for ease in attaching orifice flanges and recording meters. To simplify supporting such gas lines under relatively high pressure, this inexpensive pipe support was made.

Salvaged four-inch or three-inch pipe was cut to lengths depending on the depth of holes dug in the ground. (If these supports are to be set in concrete, their length need not be more than 3½ to 4 feet over-all. They may be more than four feet if driven into soft ground.) The tops of the supports were cut off perpendicular to the pipe, and a small section of the pipe was cut away from each side to permit the use of a wrench when bolting the pipe to the support.

A short piece of strap steel was welded to the top of the pipe as shown. Holes burned in either end of these tabs accept the treaded ends of U-bolts. The flow line was placed on top of the support and the U-bolts inserted in position. When the bolts were tightened, a substantial support resulted.



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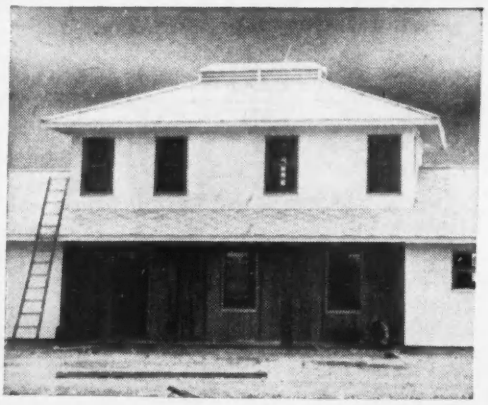
CASE HISTORIES of Houston Ready-Cut Installations



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The Wilson Type "MB" Packer, with Hold-Down is Full Opening. It will *hold,* regardless of how low the well is swabbed, as it will hold a high differential from underneath, assuring an efficient Acidizing or Hydrafrac job.

This Tool is *SOLD,* not rented, therefore it is not necessary to kill your well after completing job.

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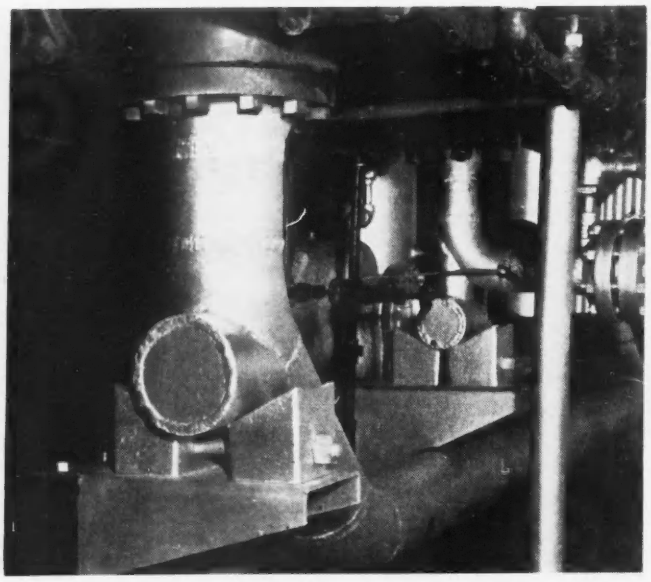
HOW TO—Support Discharge Piping from Compressor



Two metal wedge blocks that can be forced together provide adequate support for the discharge piping of a gas compressor, and also serve as a lifting device. This system was installed on several compressor units employed in a pressure maintenance project to facilitate connection and removal, as well as provide proper support, of the discharge line which delivers gas into the injection line.

A base for the steel wedges was made of steel plate by forming a channel section and cutting the sides in a taper as shown. This base was bolted to the concrete foundation for the compressor. Each wedge was made from square sections of steel forms, measuring four inches on each side. They were drilled with ¾-inch holes so a makeup bolt could be inserted through two of them. The base bolted to the concrete foundation is directly below the pressure discharge opening in the compressor cylinder.

To utilize this principle of wedge support, a bearing surface had to be added to the discharge piping. This requirement made it necessary to add more welding to the piping in the form of a horizontal takeoff blanked off as shown. In this case, the discharge is about six inches in diameter, and the line makes a 45-degree bend before leveling off just above the floor. The short section of pipe forming the bearing surface does not connect into the discharge line, but is merely welded to it. This principle can be modified to suit many different piping designs. The wedge is the secret of this innovation, and it has eased the job of removing or installing the discharge piping.

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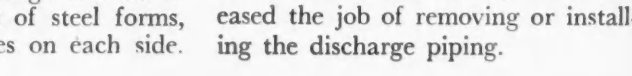

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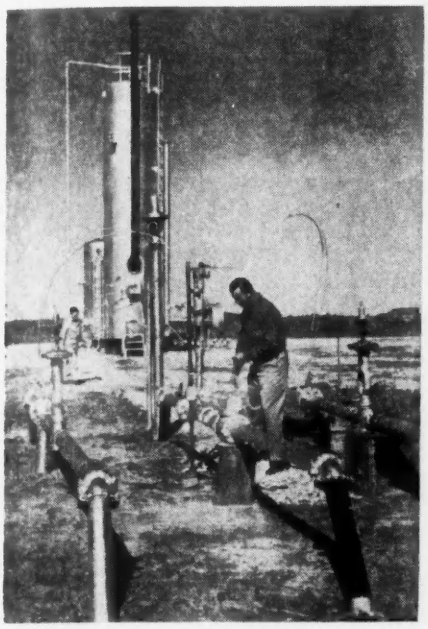

HOW TO—

Connect One Meter To Three Gas Lines

On leases where there are multiple separators to take care of high gas-oil ratio wells and high water producers, it is necessary to have two or more vent lines. One company uses the same meter for three meter runs and connects the orifice flanges to the meter on the center run with overhead flexible tubing.

In the photograph, two separators and a heater-treater are shown. The wells producing water are flowed directly into the heater-treater, and the flowing wells are divided between a high-pressure and a low-pressure separator, depending on the amount of gas produced with the crude oil.

Since the gas is not sold through these meters, a good estimate of the daily production can be determined by measuring the gas through each meter run long enough to establish the average differential and pressure; from these values, the daily volume can be calculated.

When individual wells are given the periodic gas-oil ratio tests, the other wells are switched out of any one of the separators and the well to be tested is flowed under normal conditions through its own separator. The overhead tubing permits the meter to record the flow of the well on test.

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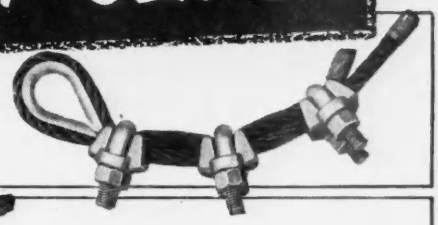
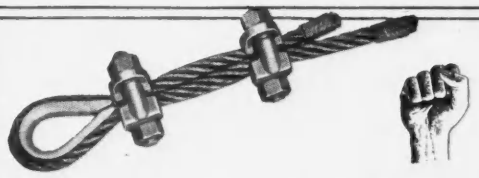
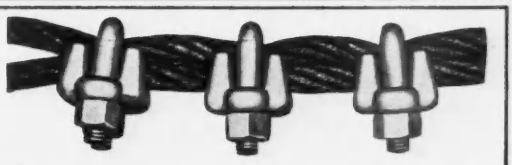
Round U-Bolts *crimp* wire rope in forcing live rope against saddle.

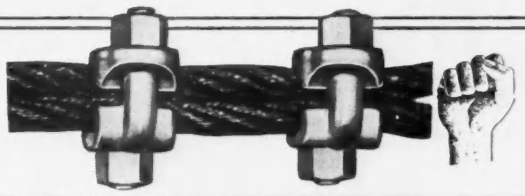




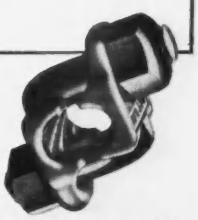
Laughlin "Fist-Grip" Clips safely secure rope on all 4 sides.

Crimping action of U-bolt leads to early breakage, costly replacement.





"Fist-Grip" Clips with all-around grip keep rope smooth — deliver maximum rope strength.



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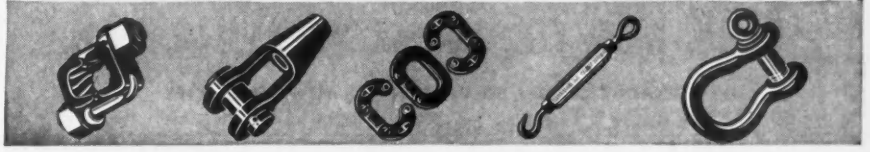
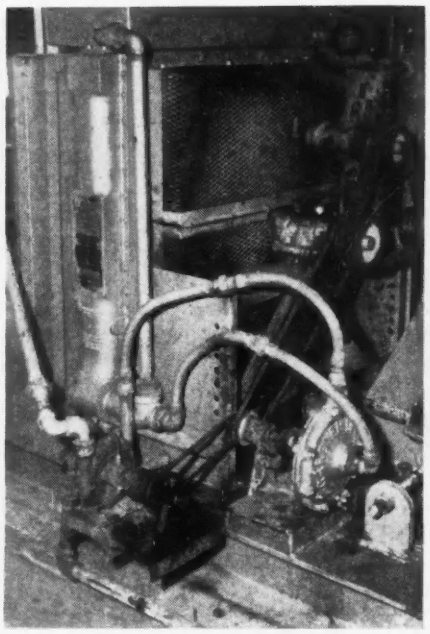


HOW TO—Provide Adequate Cooling for Gas Engine

Additional cooling of the gas-fueled engine driving a gas compressor in gas-lift service was provided by a takeoff from the driving shaft to a small centrifugal water pump. Since the compressor and driving engine were completely enclosed within a metal building, it was necessary to provide extra cooling for the engine, particularly in summer. By circulating greater than usual quantities of water through the radiator the engine was cooled to its normal operating range.



This large gas engine is used to compress natural gas taken from separators at 23 pounds per square inch up to 720 psi. Since heat hampers successful indoor operation of standard radiators, the continuous circulation of water through the radiator brings the engine temperature to recommended operating ranges.

Illustrated is the jacket water and interstage cooler, which was driven off the shaft extension from the engine clutch. A fourth groove on the fan sprocket carries a V-belt that powers a centrifugal pump which circulates compressor jacket water. From the small pump sprocket a second V-belt takeoff powers a second and even smaller centrifugal pump. This 1½-inch pump is mounted on a platform extended from the skid containing the engine and jacket water and interstage cooler.

Suction for the pump is tied to the bottom of the engine radiator through a 1½-inch pipe. Discharge from the pump is into a 1½-inch line which flows into a water reservoir. From this reservoir, water flows by gravity into the radiator, and back again to the small pump. Since a large volume of water is involved, additional cooling results.

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SIMPLIFIED GAS PIPE LINE CALCULATIONS

By J. T. HULL

Southwest Gas Producing Company, Inc.

THE CHARTS presented by the author will afford engineers a handy tool in gas pipe line calculations. Chief advantage of the charts lies in the simplification of Reynolds number calculations without great sacrifice in accuracy.

NOMOGRAPHS can speed and simplify gas pipe line calculations without appreciable loss in accuracy. An excellent nomograph[1] published recently allows direct determination of Reynolds numbers when variables are known in the fundamental equation:

$$Re = \frac{DV\rho}{\mu} \qquad (1)$$

While the nomograph in reference (1) is very convenient for liquid flow, it is not directly applicable to flow in high pressure gas pipe lines. This is because gas volumes are measured as cubic feet at some specified base temperature and pressure, and it becomes necessary to convert from base temperatures and pressures to actual temperatures and pressures in order to obtain linear velocities and densities.

$$V = \frac{Q \times P_b \times T_a \times Z \times 4}{86{,}400 \times P_a \times T_b \times \pi D^2} \qquad (2)$$

$$\rho = \frac{28.966 \times P_a \times T_b \times G}{379.5 \times P_b \times T_a \times Z} \qquad (3)$$

Substitution of Equations (2) and (3) in Equation (1), and eliminating terms gives

$$Re = \frac{1.1248 \times Q' \times G}{D\mu} \qquad (4)$$

Where Q' = Million Std. Cu. Ft.

It has previously been shown by such investigators as Dr. G. G. Brown[2] that the viscosities of natural gases at pressures of one atmosphere are essentially functions of the molecular weights of the gas mixtures at specified gas temperatures. Figure 1 has been prepared using these data[2], and the molecular weight variable has been converted to a gas gravity parameter. Figure 1 shows that viscosity changes only slightly with tempera-

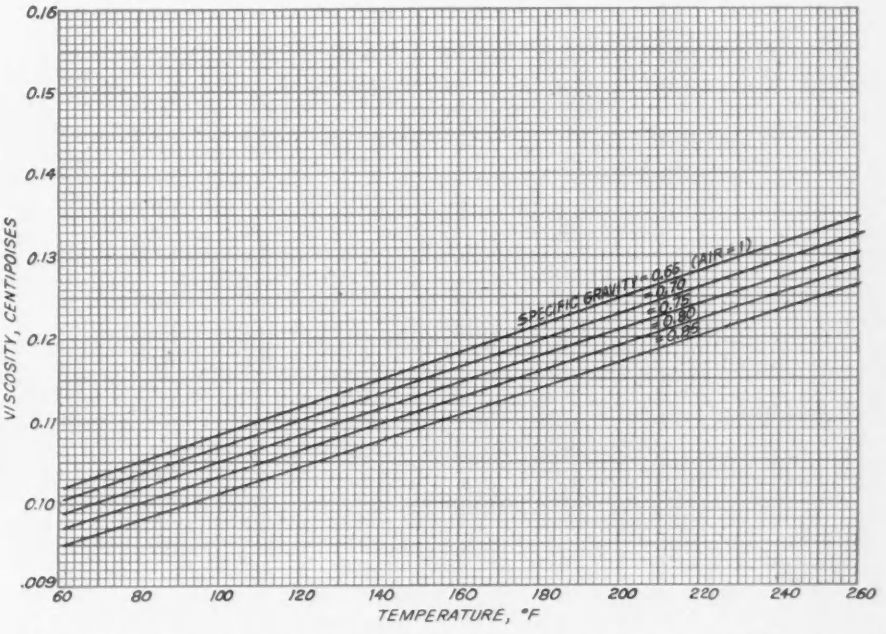

FIGURE 1. Viscosities of paraffinic hydrocarbon gases at one atmosphere. (Based on data of G. G. Brown.)

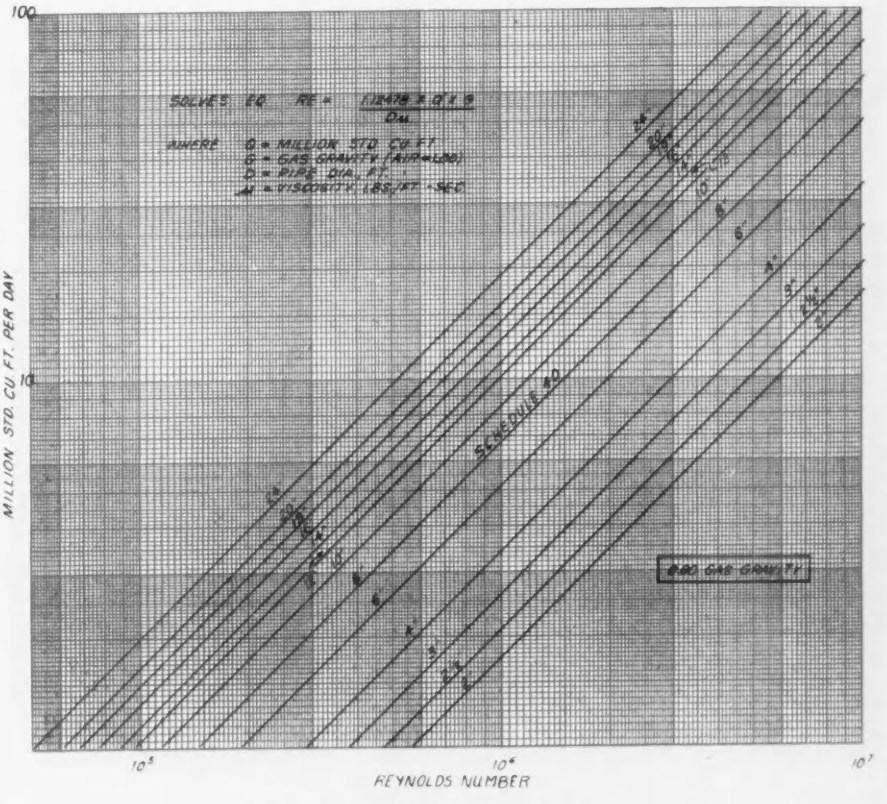

FIGURE 2. Reynolds Number vs. Gas Rate.

ture, and increases very nearly as a linear function over the temperature range plotted. From the foregoing, it is seen that a series of charts may be prepared for different gas gravities by plotting gas rate versus Reynolds number for various pipe diameters. Figures 2, 3 and 4 have been constructed in such a manner for gas gravities of 0.60, 0.65 and 0.70, respectively, with the gas viscosity being that at 60° F. and one atmosphere

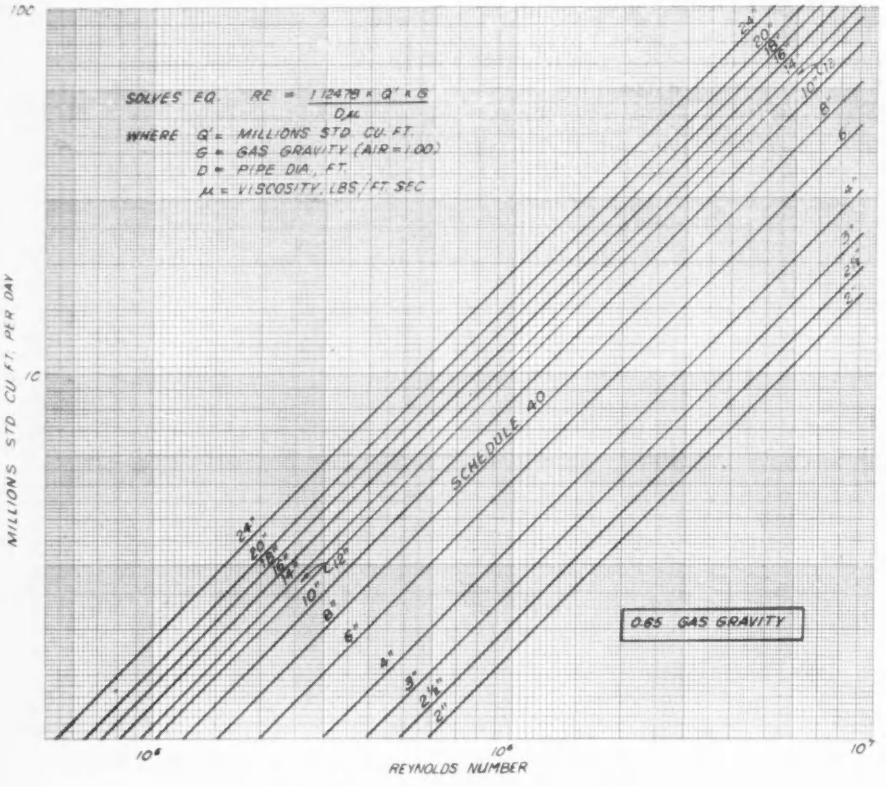
SOLVES EQ. RE = 1.12478 × Q' × G / D μ
WHERE Q' = MILLIONS STD. CU. FT.
G = GAS GRAVITY (AIR = 1.00)
D = PIPE DIA., FT.
μ = VISCOSITY, LBS./FT. SEC
SCHEDULE 40
0.65 GAS GRAVITY
MILLIONS STD. CU. FT. PER DAY
REYNOLDS NUMBER

FIGURE 3. Reynolds Number vs. Gas Rate.

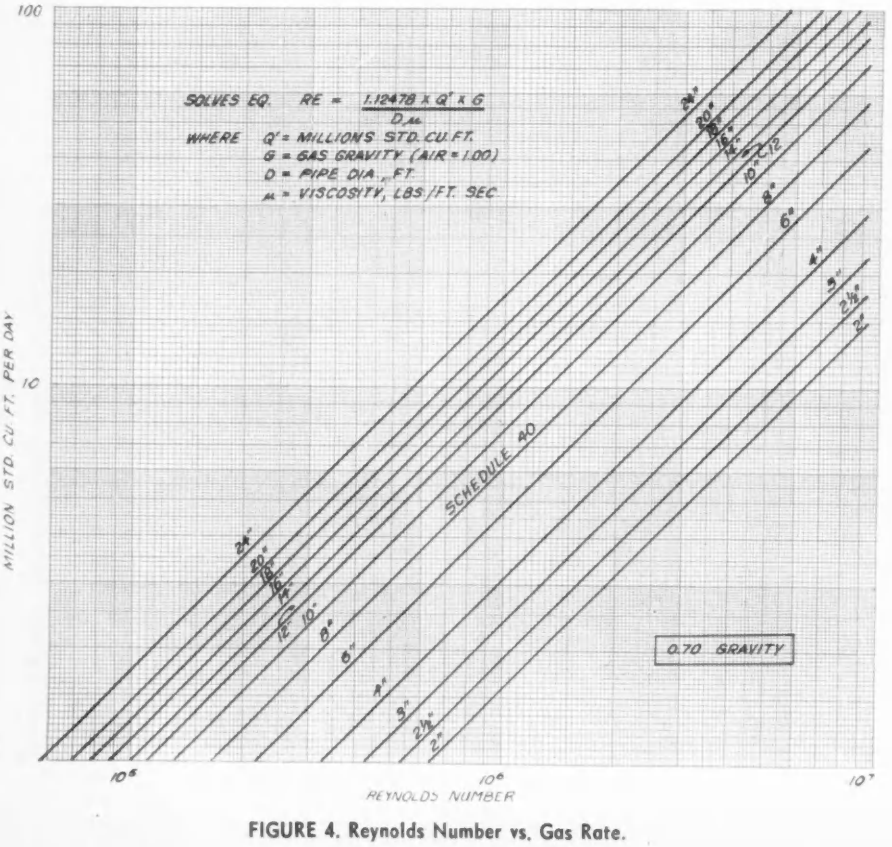
SOLVES EQ. RE = 1.12478 × Q' × G / D μ
WHERE Q' = MILLIONS STD. CU. FT.
G = GAS GRAVITY (AIR = 1.00)
D = PIPE DIA., FT.
μ = VISCOSITY, LBS./FT. SEC
SCHEDULE 40
0.70 GRAVITY
MILLION STD. CU. FT. PER DAY
REYNOLDS NUMBER

FIGURE 4. Reynolds Number vs. Gas Rate.

and the pipe sizes for Schedule 40 pipe.

The effect of pressure on gas viscosity has been presented by Comings and Egly[3] in the form of a generalized chart based on reduced properties, and is shown in Figure 5. It is seen that at low pressures the effect of pressure is not too appreciable, but that it increases in importance as the pressure is increased. Also, since deviations from Charles' and Boyles' Laws must be considered at higher pressures, and due to the fact that gas law deviations may be presented in the form of generalized charts[4] involving reduced properties, it is a simple matter to obtain pressure corrections to viscosity from Figure 5 and the reduced properties obtained in determining compressibility.

It is recommended that the charts be used in the following manner:

(1) Read the Reynolds number from the chart for the appropriate gas gravity.

(2) Obtain the pressure correction to viscosity from Figure 5.

(3) For temperatures from 60° to 100° F., it is felt that no temperature correction is necessary. For temperatures above 100° F., read a temperature correction factor from Figure 6.

(4) Divide the Reynolds number in (1) by the factors obtained in (2) and (3) where they apply, in order to obtain a corrected Reynolds number.

It is apparent that the chart may be read directly for a conservative approximation without applying corrections, and the corrected Reynolds number used where more accurate figures are desired.

EXAMPLE 1:

Determine the Reynolds number for a natural gas having a gravity of 0.65, flowing in a six-inch XXH line (I.D. = 4.897 inches) at an average temperature of 80° F. and a pressure of 3000 pounds per square inch gauge, at a rate of 20 million standard cubic feet daily.

From Figure 3, the Uncorrected Reynolds number 5,100,000

From CNGA Bulletin[5]

$$P_c = 678 \qquad P_R = \frac{3015}{678} = 4.45$$

$$T_c = 372 \qquad T_R = \frac{540}{372} = 1.45$$

From Figure 5, the pressure correction to viscosity 2.03

Corrected Reynolds number =

$$\frac{5{,}100{,}000}{2.03} = 2{,}510{,}000$$

Solution by Equation (4):

$$Re = \frac{1.1248 \times 20 \times 0.65 \times 12}{4.897 \times .0102 \times 2.03 \times 1.032 \times .000672} = 2{,}500{,}000$$

(Where 1.032 = temp. correction read from Figure 6.)

This difference is so slight that it would not effect a friction factor reading.

Application to Fanning Equation for Pressure Drop in Gas Pipelines

The Fanning equation for pressure drop may be written in the form

$$\Delta P = \frac{2fLV^2\rho}{gD} \qquad (5)$$

Substitution of Equations (2) and (3) in equation (5), and collecting constants for gases at Standard Conditions gives

$$\Delta P\ (PSI) = \frac{0.0002021\ fL\ (Q')^2\ T_s\ GZ}{P_s\ D^5} \qquad (6)$$

EXAMPLE 2:

Determine the pressure drop per mile for the gas given in Example 1.

$L = 5{,}280$ ft.
$f = 0.00332$
$Z = 0.760$
$D^5 = (4.897/12)^5 = 0.0113$

$$\Delta P = \frac{0.0002021 \times 0.00332 \times 5280 \times 400}{3015 \times 0.0113} \times \frac{540 \times .65 \times .76}{1} = 11.1 \text{ psi.}$$

Application to Weymouth Equation

Weymouth's equation may be written

$$Q = 38.774 \times \frac{520}{14.696} \left[\frac{d^5 \times (P_1^2 - P_2^2)}{fGTLZ_m}\right]^{1/2} \qquad (7)$$

EXAMPLE 3:

What would the upstream pressure be in a line handling 75 mm scf/d, if the I.D. of the line is 17.25", the downstream pressure is 700 psig, the gas temperature is 80° F., line length is 40 miles, and the gas gravity is 0.625?

Assume a pressure drop of 50 psi

$P_c = 679$ $\quad P_R = \frac{740}{679} = 1.10$

$T_c = 362$ $\quad T_R = \frac{540}{362} = 1.49$

$Z = .887$

Pressure Correction to Viscosity = 1.26
Uncorrected Reynolds number = 5,400,000
Corrected Reynolds number = 4,280,000
Friction factor = .00308

$$75{,}000{,}000 = 38.774 \times \frac{520}{14.696} \left[\frac{1{,}527{,}000\ (P_1^2 - 715^2)}{.00308 \times .625 \times 540 \times 40 \times .887}\right]^{1/2}$$

$P_1 = 766$ PSIA

$\Delta P = 766 - 715 = \underline{51}$ psi

NOMENCLATURE

d—pipe diameter, inches
D—pipe diameter, feet
f—Fanning friction factor
g—Acceleration due to gravity = 32.2 ft./sec.²
G—Gas gravity (Air = 1.00)
L—Length of line
feet in Equations (5) and (6)
miles in Equation (7)
P—Pressure, psia
Q—Gas rate, scf/day at 14.696 psia and 60° F.
Q'—Gas rate, mm scf/day at 14.696 psia and 60° F.
T—Absolute temperature, °R.
V—Linear velocity, ft./sec.
Z—Deviation from gas laws

GREEK LETTERS

ρ—fluid density, lbs./ft.³
μ—Absolute viscosity, lbs./ft.-sec.
Δ—Difference

SUBSCRIPTS

1—inlet
2—outlet
a—actual
b—base

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[5] CNGA Bulletin No. TS-461.

ACKNOWLEDGMENT

The author wishes to express his appreciation to R. F. Cox, Southwest Gas Producing Company, for suggestions in the preparation of the material, and to C. J. Randolph, W. W. Roberts and J. B. Watson of Girdler Corporation for reviewing the manuscript.

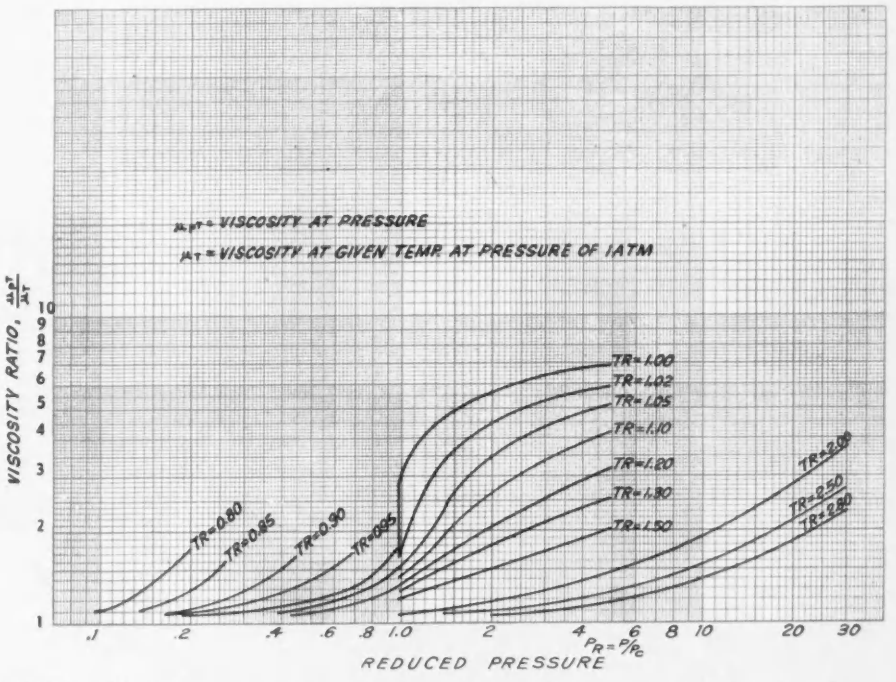


FIGURE 5. Effect of pressure on gas viscosities. (Source: Comings and Egly, Ind. Eng. Chem. 32, 714-718, 1940.)

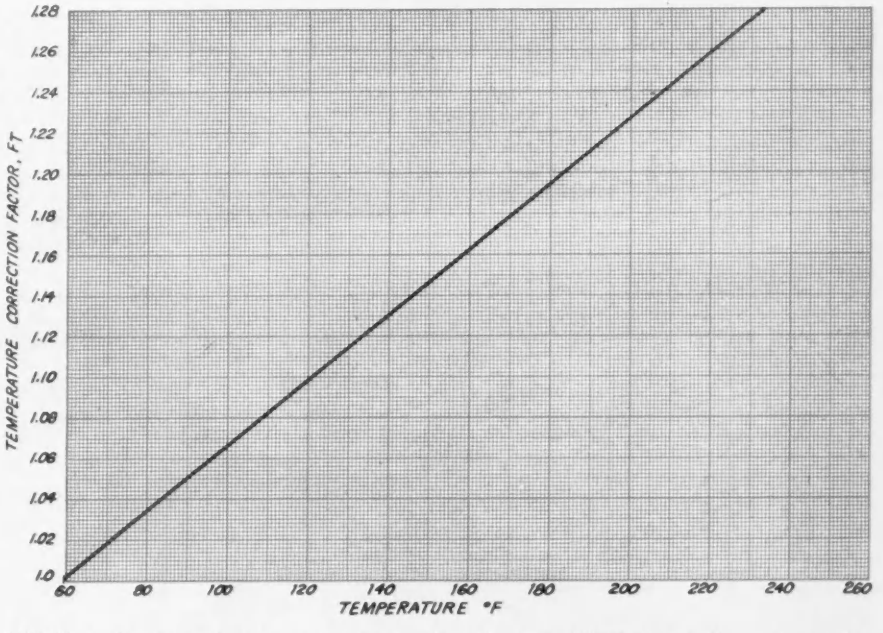
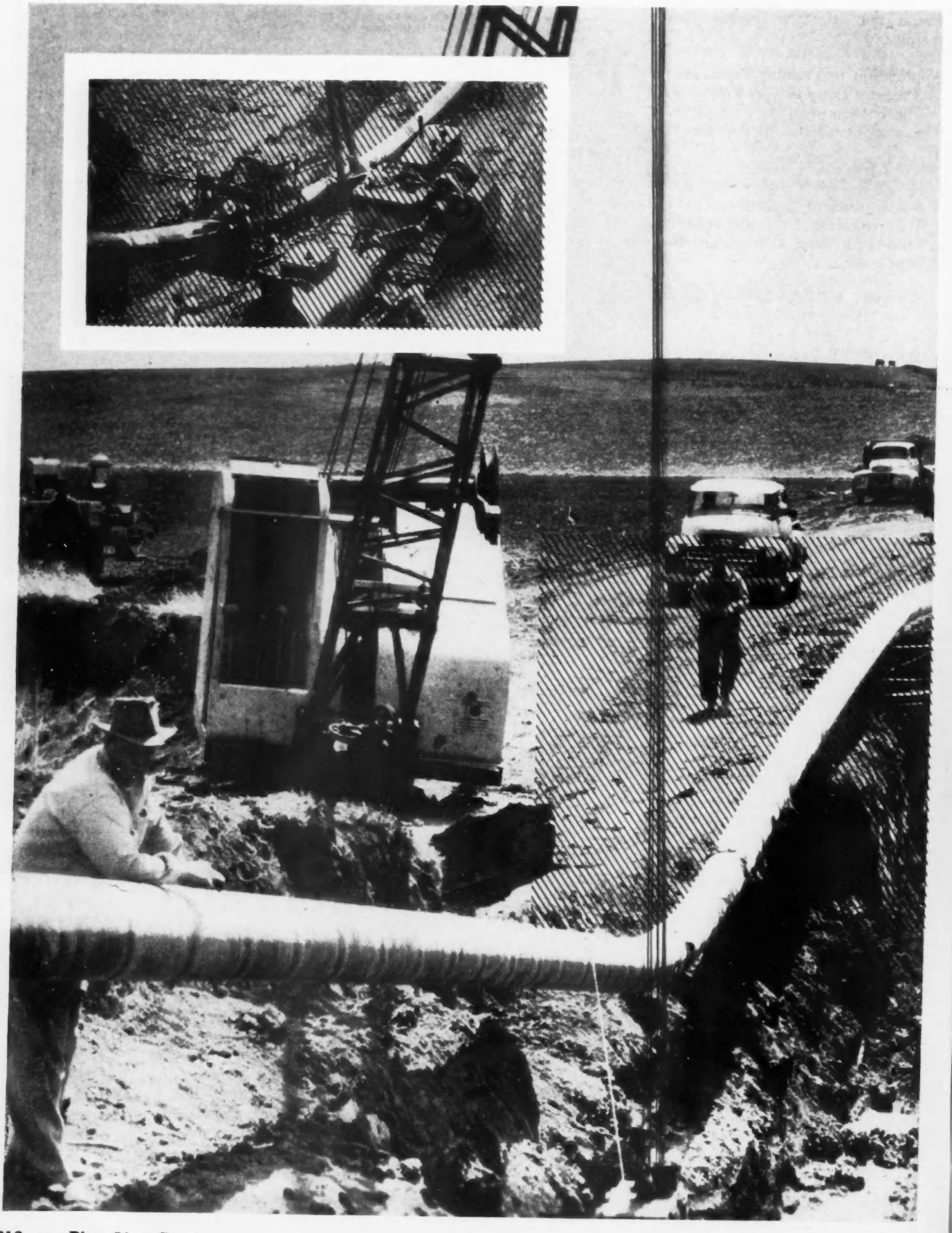


FIGURE 6. Correction factor to convert gas viscosities from 60° F. to actual gas temperature.

In the Nation's great new



underground transportation system

thousands of miles of NATIONAL Seamless Pipe are paying rich dividends in safe, dependable service

● The vast network of pipelines that carries gas, crude oil and refinery products to homes, plants, and factories of America now exceeds 533,000 miles in length . . . 136,000 miles longer than our total railway mileage.

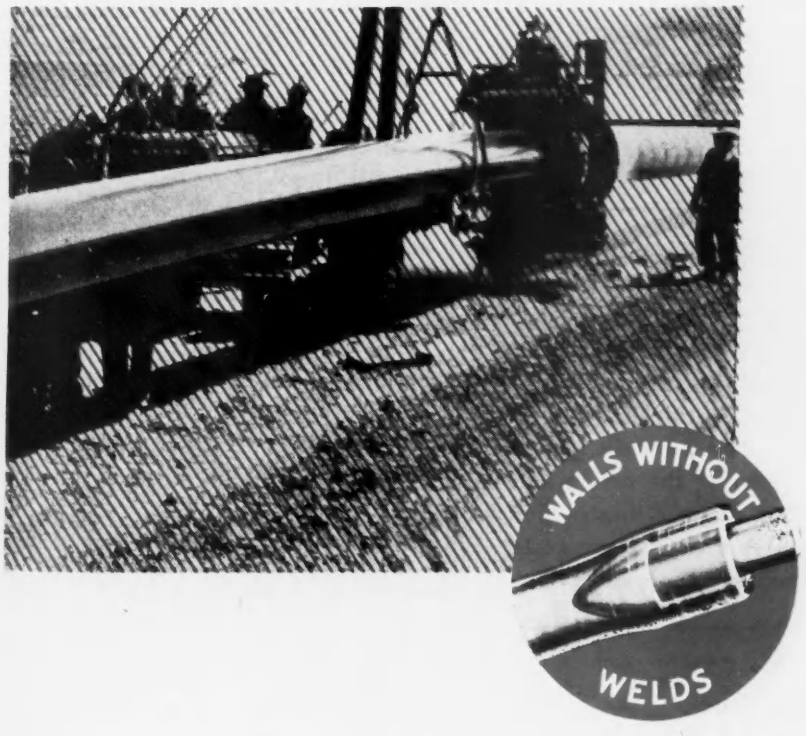
8 out of every 10 barrels of crude oil today move to U. S. refineries by pipeline. Natural gas sales are up 50% since 1945 and all the gas moves through pipelines.

Pipelining is big business. This year alone, 20,000 miles of new pipelines will be laid. In the year just past, the pipeline bill totalled a record-breaking $1 billion plus.

Since the very beginning of this vitally-important transportation system, NATIONAL Seamless Steel pipe has been used in ever-increasing quantities. Thousands upon thousands of miles are now in service. The famous "Big Inch" line was built almost entirely with NATIONAL Seamless . . . the first, and still the finest seamless pipe produced in the United States.

For NATIONAL Seamless is pierced from a solid billet of high-quality steel . . . the one method that removes all doubt concerning uniform wall strength. In these famous "Walls without Welds" there are no lines of potential weakness—no longitudinal welds to weaken or injure the pipe. As a result, pipeline companies have *confidence* in NATIONAL Seamless. They know from experience that money just can't buy anything better.

In the future, as in the past, NATIONAL Seamless quality will be jealously maintained to the same high standards that has made it preferred not alone for pipelines but for drill pipe, casing and tubing as well.



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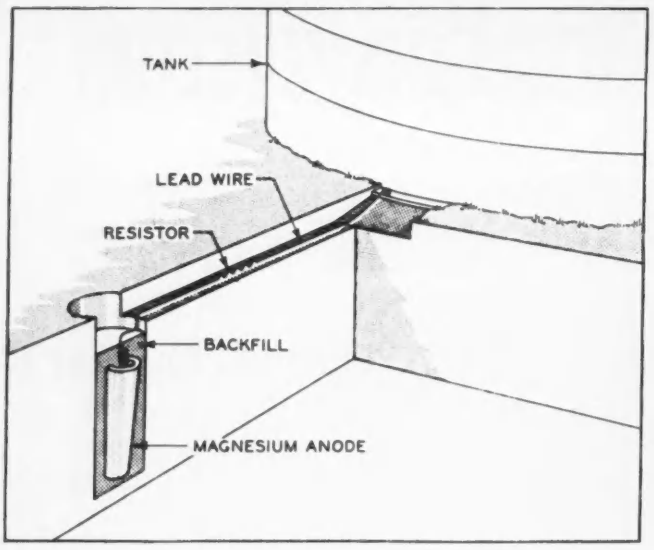

FIGURE 1. For protecting the bottoms of steel storage tanks the magnesium anodes are installed in a circle around the tank and connected to the tank bottom as shown.

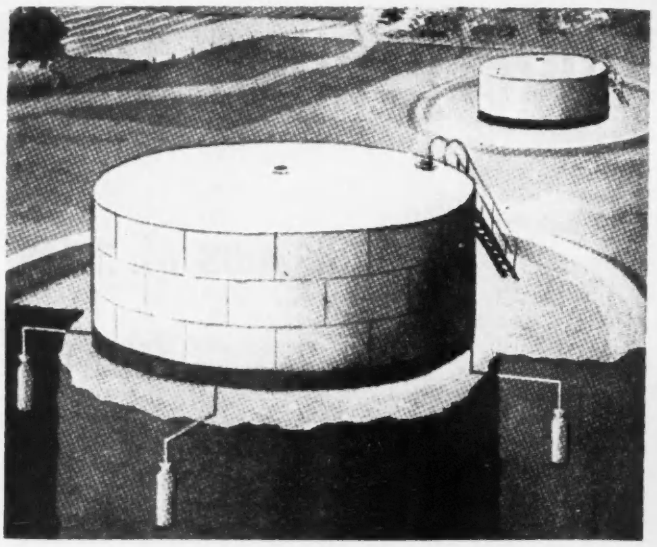

FIGURE 2. Where tanks are relatively wide spaced, it has been found advantageous to install individual anodes close around the periphery of the tank as illustrated.

Cathodic Protection of Tank Bottoms

PROTECTION OF tank bottoms from external corrosion costs about 1½ percent of the replacement cost per year. For most installations corrosion protection is economically justifiable. Carefully planning the cathodic protection system during the design and engineering stages of construction will pay off in extended service life of the tanks.

CORROSION of oil storage tank bottoms continues to be a serious problem. In addition to the reconditioning or replacement costs which are a direct result of external corrosion of the tank bottoms, the possible losses of stored product and other damages deserve real consideration.

Reconditioning programs at periodic intervals are a necessary and expensive part of maintenance at most tank farms. And, depending upon the soil environment of a particular area, complete replacement of the tank bottoms can become necessary within relatively short periods of time.

In the design of an oil storage installation considerable thought is given to the location of the tanks with respect to the natural drainage characteristics of the area. After the individual tank sites have been determined, a base or pad for the tanks can be prepared to fit the soil conditions.

Usually a storage tank base is prepared so that the tank rests upon a pad of sand or gravel, at the top of a slightly conical grade. In this manner gravity drainage prevents the accumulation of water beneath the tank. Over a period of time, however, settling and silting of the pad will occur. Particularly in older installations, moisture will tend to accumulate under and around the tank, giving rise to a highly corrosive environment.

Experience indicates that cathodic protection of an oil storage tank bottom may be provided at an annual cost of approximately 1½ percent of the cost of replacing the tank bottom, through the use of magnesium anodes. In such application the small, distributed-ground system which the use of magnesium anodes offers can represent an economy in design not attainable in higher voltage, concentrated-ground, installations.

For the cathodic protection of a steel tank bottom the criterion of —.85 volt metal-to-soil potential is usually accepted as the potential at which complete protection is obtained. Similar to other types of cathodic protection installations, the current requirements (current density) necessary to provide the corrosion protection will range from 0.5 to as high as two milliamperes per square foot of the tank bottom steel, depending upon the particular corrosive environment.

Assuming that a given tank bottom would require a current density of one milliampere per square foot of bottom surface, in one year's time this would amount to 8.76 ampere-hours of current per square foot. Assuming

a tank of 80 feet diameter, the bottom surface area would be 5027 square feet. Because 8.76 times 5027 equals 44,036 this would be the number of ampere-hours of current necessary to protect the tank bottom for one year. At a current efficiency of 500 ampere-hours per pound of magnesium anode consumed, this installation would require 88 pounds of magnesium anode metal per year. Upon this basis, an installation designed for the customary ten-year life would require 880 pounds of magnesium anode metal, or 17 of the type 50-R magnesium anodes.

There are several types of magnesium anodes employed in cathodic protection of oil storage tank bottoms; the proper type to use in any given installation being determined largely by the soil resistivity at the tank site. In general, it is advantageous to use a large anode in low resistivity soils and a smaller anode in higher resistance soils. Here it should be pointed out that a proper backfill for the anode is essential if maximum current efficiency is to be obtained.

Actual Installation

In an actual cathodic protection installation of this type, it is customary to place the magnesium anodes in a concentric circle about the periphery of the tank, spaced several feet out from the base of the tank and connected to it as shown in Figures 1 and 2. In actual operation, it is rather difficult to obtain metal-to-soil potential readings from any point other than the outer rim of a tank bottom. However, field tests indicate that the potential drop toward the center of the tank bottom will amount to approximately one millivolt per foot of distance from the outside edge. Therefore, on a 55,000-barrel tank, for instance, a metal-to-soil potential of —0.90 volt at the edge would indicate approximately —0.85 volt at the center, an ample voltage for the protection of the tank bottom.

It is considered good practice to insulate all connecting pipe lines from the tank, through the use of insulated flanges at the valves or by other means. In the case where measurements following the installation indicate more anode current flow than is needed for protection of the tank bottom, due to soil or other conditions, the insertion of small resistors in the anode leads will greatly increase the life of the installation, cutting the over-all costs.

ACKNOWLEDGMENT

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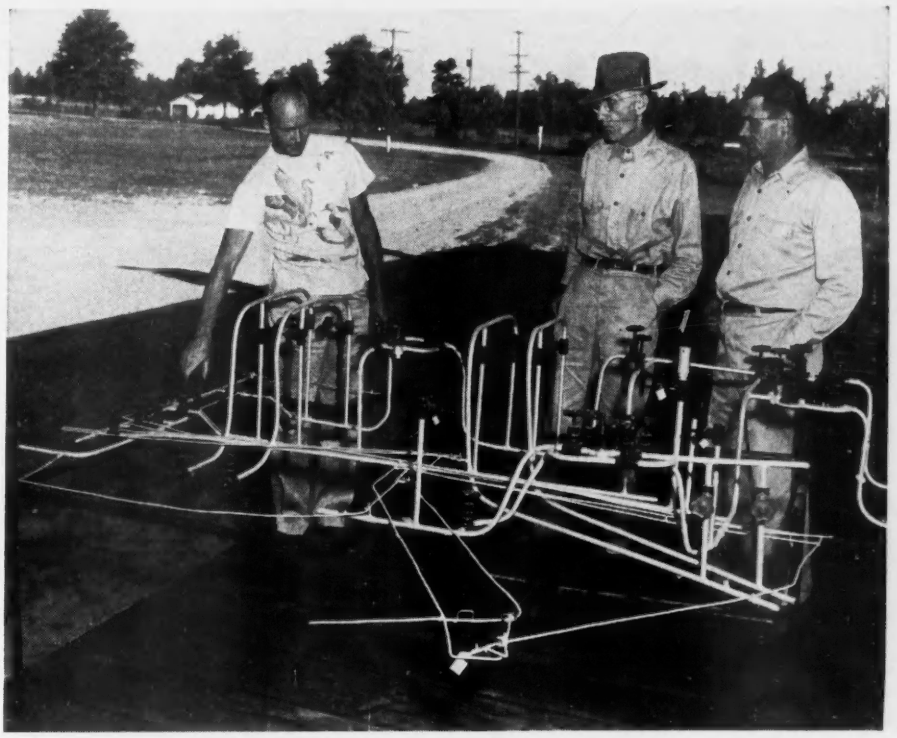


Exact replica of station piping at Sarepta built by M. H. Craig, shown turning the valve at left. F. L. Denmon, center, and O. L. Corwine, right, look on.

Model Aids Station Personnel

THE apparatus in the accompanying photo might look like a plumber's nightmare, but actually it is an exact replica of the piping arrangement at Sarepta compressor station in the Shreveport district of United Gas Pipeline Company.

It was designed and built by M. H. Craig, meter inspector in the Sarepta area, to serve as a visual aid for operating personnel of the station. Craig's idea was that the unusual model would help all station employees become more familiar with the piping.

Sarepta, like any compressor station, has a maze of inlet and outlet lines, many of them underground. All are connected by valves for the various interchanges of flow that become necessary for one reason or another, and station personnel must be able to halt or switch the flow of gas quickly when the need arises. To be able to do it efficiently, they must be familiar with the piping arrangement.

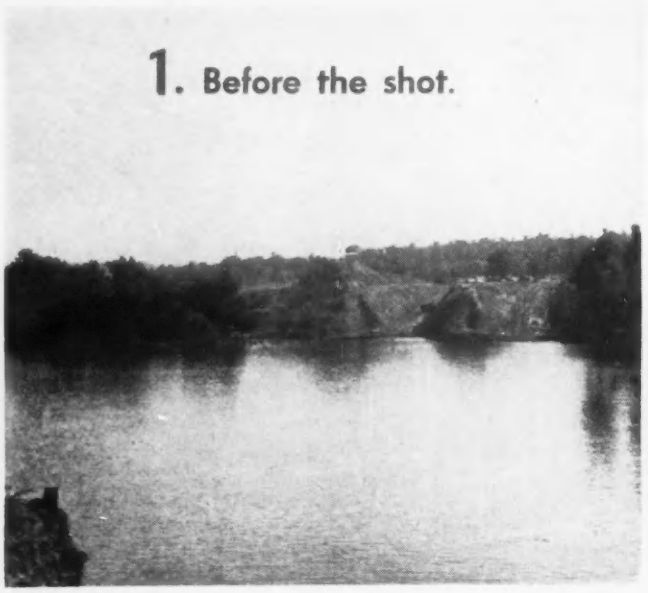
The entire system of piping at Sarepta was re-arranged in 1948, and there are two inlet lines from Cotton Valley, two from Latex, and two outgoing lines—one to Sterlington and one to a paper mill at Springhill.

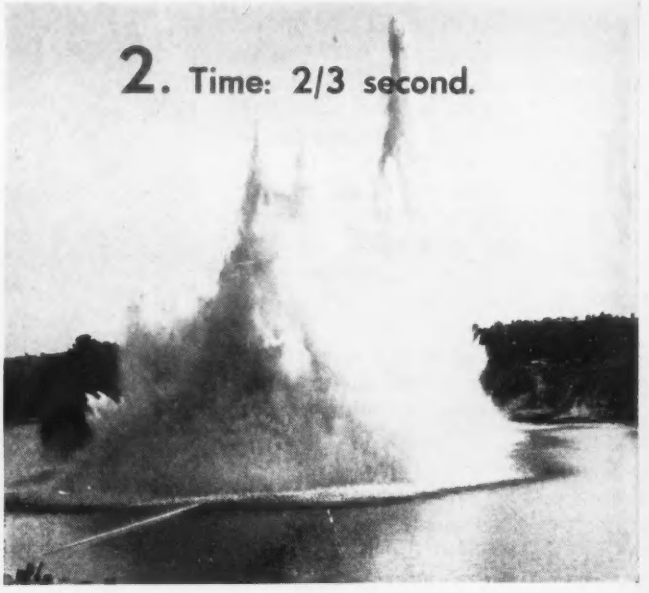
Craig built his above and below-ground model with one-fourth-inch scrap pipe and one-fourth-inch discarded needle valves. He painted one side of the valves red and the other side green to show which were closed and which were open under different operating conditions.

Fuel lines for the station were added to the model by J. O. Dean, first engineer. Welding rods were used for these smaller lines, also visible in the picture.

The miniature manifold has already become extremely popular and valuable at Sarepta. However, one of its greatest values will come in the training of new employes or those transferred to the station from other points in the system. By close study of the model they can learn in short time the exact arrangement of every inlet and outlet line in the piping system.

From United Gas Log.





SHOOTING A CUMBERLAND RIVER CROSSING

Ditching with Explosives

By WILLIAM G. PIPER, Atlas Powder Company

PROPERLY handled, explosives can speed pipe line construction, even when heavy rock excavation is encountered. Improperly handled, explosives can be dangerous and inefficient.

Proper handling of explosives starts with management, whose responsibilty it is to select competent personnel to direct work. When rock work on a spread is of such magnitude that several drilling and blasting crews are required, a blasting engineer or foreman should take responsibility for drilling and shooting. The contractor should provide a large central magazine to receive and store deliveries or explosives; a well-organized system should be provided for making deliveries to portable magazines located near each rock crew.

Explosives should be accessible only to authorized personnel and all unused blasting supplies should be locked in magazines at the end of each day. Most accidents to non-construction personnel can be traced to carelessness in retrieving unused caps or explosives at the end of the day's work.

Rock Excavation

Photo at right shows a backhoe easily handling well-broken material on a pipe line operation in the rugged mountain country of Kentucky. Two and one-quarter-inch holes were drilled with twin wagon drills suspended from a crawler tractor. Staggered rows of holes were spaced four feet apart, with the holes on 3½-foot centers. Depth of the holes was seven feet to allow for a 30-inch minimum cover on the 30-inch pipe line.

Forty percent ammonia gelatin cartridges, 1½ x 8 inches, were loaded in the holes and detonated with cap and fuse. Good results in ditching were obtained by using cap and safety fuse priming. The latter burns at a rate of approximately 40 seconds per foot.

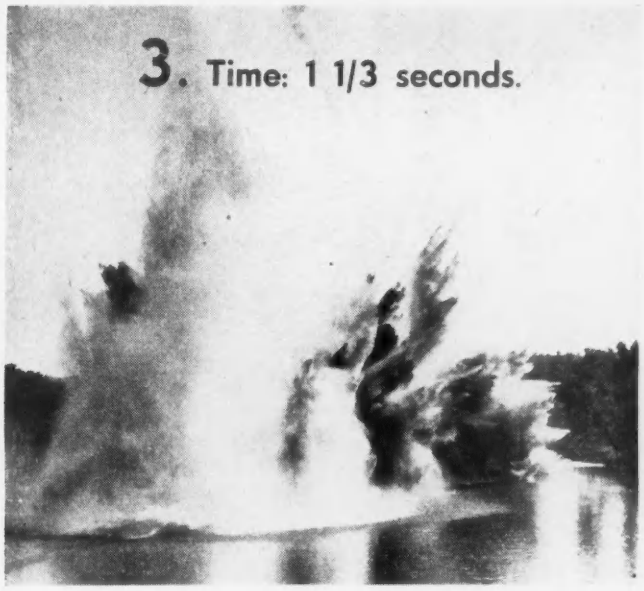
In wet areas special fuse is used to avoid misfires. However, use of this fuse should be limited to wet areas because of excessive side breaks encountered in dry areas.

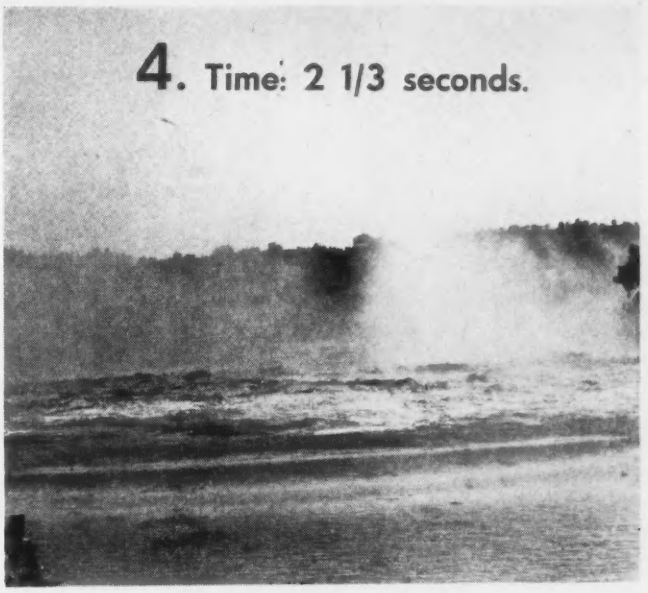
Where water conditions are uncertain, 40 percent ammonia gelatin is the best general purpose explosive. Forty percent extra dynamite is a more economical powder to use where no water is encountered.

Here are a few common-sense safety rules which should always be observed when blasting rock:

- Drill holes should be allowed to cool before loading.
- Fine dirt makes an excellent stemming material. Rocks should never be tamped in holes.
- If electric blasting caps are used, leading wire and blasting machines should be kept in good condition.
- Circuits should be tested with a blasting galvanometer before firing.
- When blasting in heavily popu-

Backhoe removes rubble following blasting.





The author details common-sense principles to be employed in explosive handling and utilization to cut pipe line ditch through rock surfaces and across rivers and lakes.

lated areas, only a few holes should be fired at a time. Sometimes blasting mats should be used.

River Crossing With Explosives

There are two methods commonly employed in blasting river crossing ditch: String shooting, and drilling and shooting.

String shooting, often used to break through a layer of shale or hard pan, refers to the method where explosive charges are attached to a wire rope and tugged across the river bed and detonated. Drilling and shooting, used to excavate rock from river bed, makes use of individually drilled holes penetrating several feet into rock, loaded, and detonated.

Selection of method in shooting depends on geological conditions encountered in probing or test hole drilling.

For best results with the string shot method, subsurface of the river bed should be carefully explored before shooting. This method works best where subsurface material below proposed depth of the ditch is loose and unconsolidated. The nature of this material can usually be determined by probing the river bed with a punch bar or by drilling exploratory holes along the ditch line. In deep water, probing should be done by a diver.

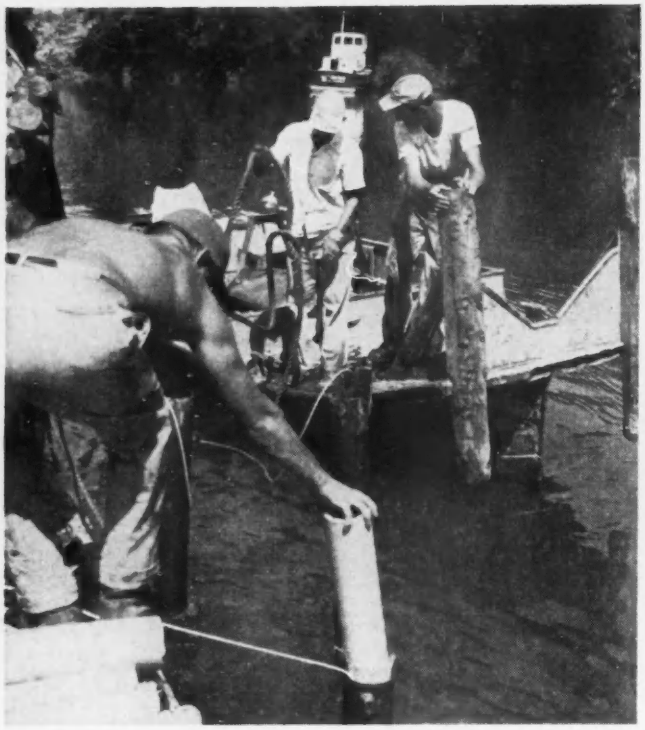
Because considerable material will be washed back in the ditch by the returning water and the river current, the blast should not be under loaded. High velocity gelatin is recommended for this type work. Experience has shown a five-or six-inch diameter cartridge weighing 25 pounds to be easy to handle. When strung end to end on a one-half inch to seven-eighths inch cable (depending on the width of the river) with bailing wire. A double line of plastic-covered fuse is strung along the cartridges to insure detonation throughout the string of explosives.

Prior to pulling the string across the water a diver should walk the line to make sure there are no stumps or obstructions on the river bottom. A protective shield placed on the cable in front of the first cartridge helps protect the explosives from obstacles when the string is pulled into place. After the pull it is a good idea to have the diver again walk the string of explosives to make sure it is on line and in contact with the river bottom.

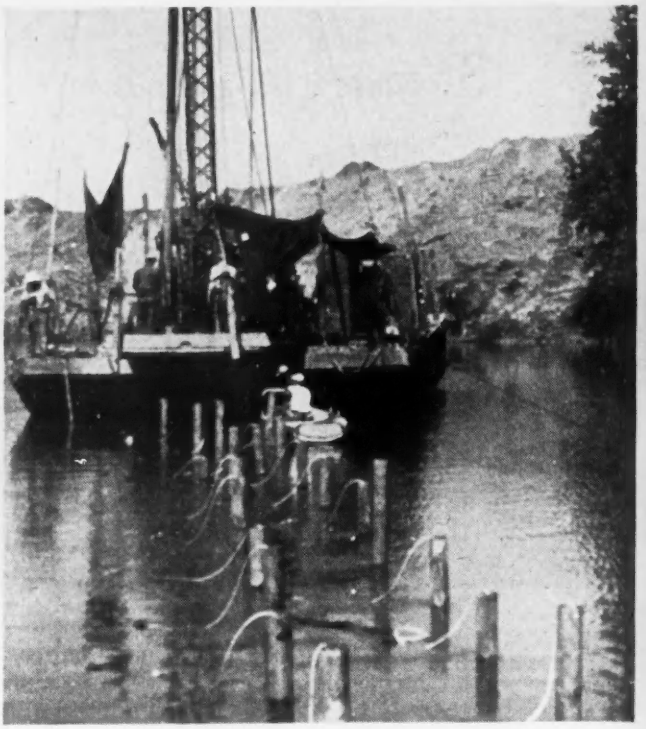
Loading shot holes behind wagon drill.

Loading Drill Holes

When drilling the river bottom is required, the usual procedure is to drill and case holes with a well drill rig mounted on a barge. Photos above show a river crossing blast for a 30-inch line across the Cumberland River



Loading a 35-foot deep hole with cartridges of 60 percent high velocity gelatin.



Well drill pulling casings after holes have been loaded.

in Tennessee. About 10,000 pounds of explosives were used in this blast. Sixty or 75 percent high velocity gelatin is recommended for this work.

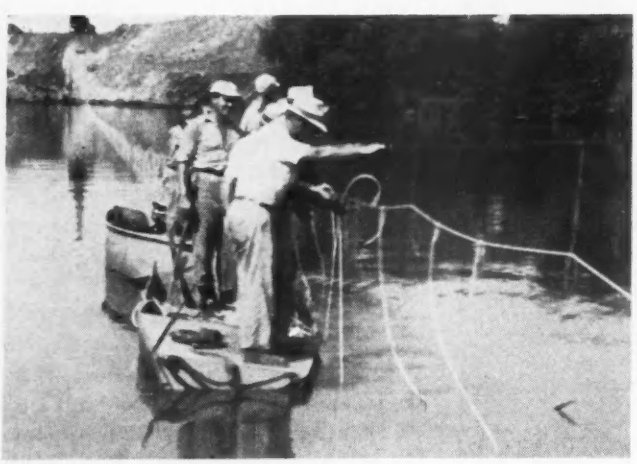
In this case the water was more than 20 feet deep. Holes were drilled through six feet of loose material and six feet of rock for a total depth of 35 feet below surface. Two staggered rows of holes were drilled three feet apart with the holes in each row on six-foot centers.

Plastic-covered detonating fuse was tied to the first cartridge and lowered into each hole for a primer. The rest of the cartridges, 4½ inches in diameter and weighing 16⅔ pounds, were lowered into the holes.

Where the river current is not too swift, a saving can be realized by pulling the casings before blasting. Photo at right above shows the drill barge following the loading crew pulling the casings. Note the wooden floats attached to the end of the fuse so it can easily be fished out to attach to the trunk line.

The detonating fuse trunk line was suspended from a three-eighths inch cable with binder twine and the fuse from each hole tied to it. Two electric blasting caps were taped on the end of the trunk line. The blast was detonated at a point 500 feet back from the river bank with a blasting machine. It is extremely important to make sure all personnel is well back from the blast, particularly for shallow-water blasts or where casings may be blown to pieces or thrown high in the air.

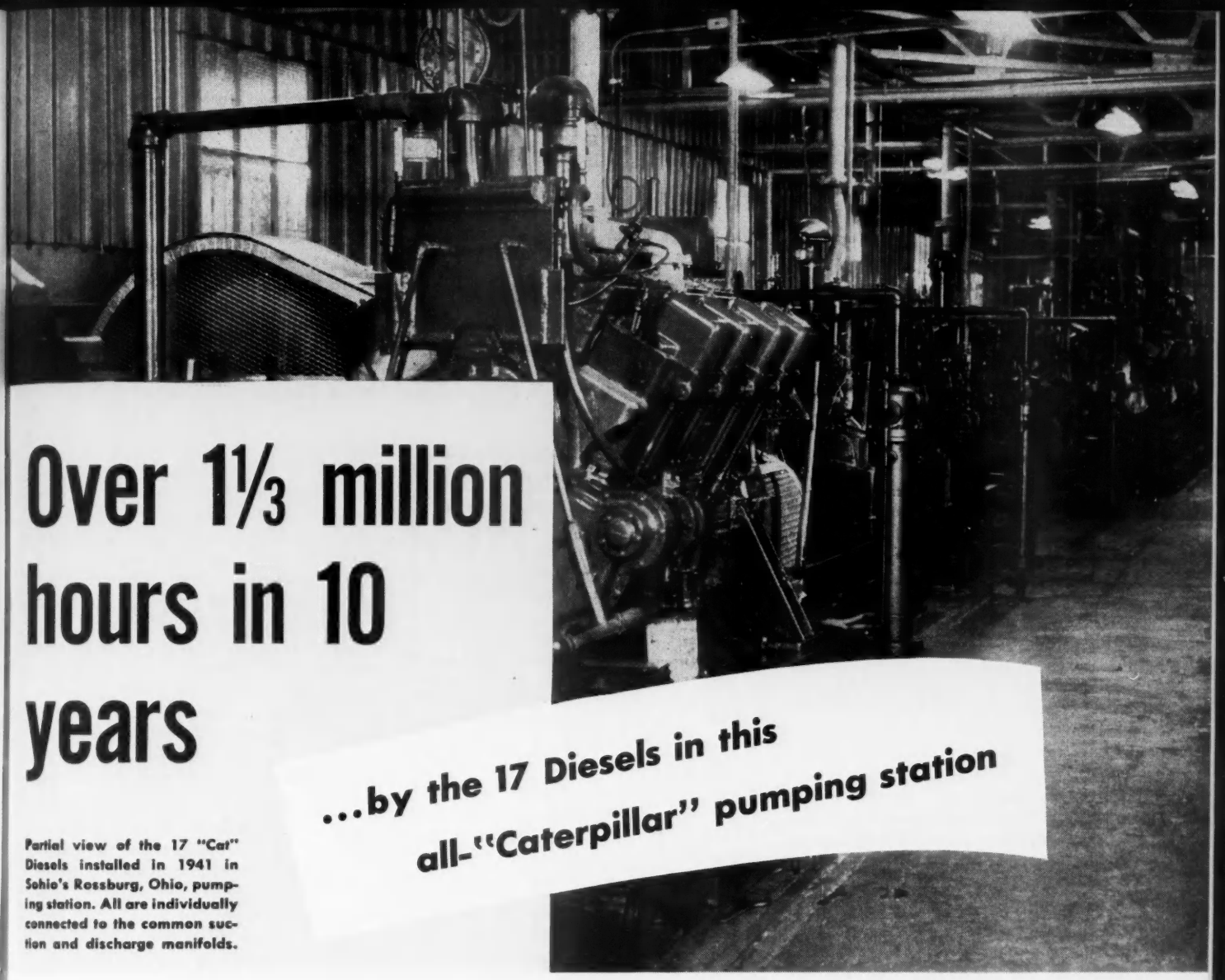
In some shallow-water blasts the rock has been completely blown from the ditch, and the pipe line laid immediately. In deeper water the ditch must usually be cleaned out with a clamshell. High spots can sometimes be broken with a small string shot. The greatest economy in a river crossing is to make the required ditch on the first shot.



Tying fuses to main trunk line detonating fuse.

About the Author

WILLIAM G. PIPER was graduated from the Pennsylvania State College in 1943 with a B.S. degree in mining engineering. After serving more than three years with the Marine Corps engineers, he returned to Penn State for graduate work and then joined Atlas Technical Sales Division in 1948 as a technical representative.



Over 1⅓ million hours in 10 years

...by the 17 Diesels in this all-"Caterpillar" pumping station

Partial view of the 17 "Cat" Diesels installed in 1941 in Sohio's Rossburg, Ohio, pumping station. All are individually connected to the common suction and discharge manifolds.

If ever a "case history" testified to the long life and continuous operation of "Caterpillar" Diesel Engines, this installation does so convincingly. Here, at the Sohio Pipeline Company's Rossburg, Ohio, station, 17 "Cat" Diesels (D17000s and D13000s) have been in active service for ten long, hard-working years. One serves as oil-change standby. Another is standby for overhauls, tune-ups and parts replacements. Thus, 15 engines are always running—24 *hours a day.*

Deducting down-time for overhaul (about every 5,000 hours per unit) and servicing, the group has rolled up approximately 1,400,000 engine hours. This does not include the fact that nine of these engines had seen service before being installed at the Rossburg station. Their further, unspent life still challenges an accurate guess!

Sound engineering and earnest manufacture are the basis for these Diesels' quality and sturdiness. Sensible care and maintenance have been the pay-off in their record of dependable performance. Yet, their history is but a reflection of the individual history of thousands of mates at work in the oil, mining, quarrying, contracting, lumbering, transportation, fishing and other industries.

A timely word: The finest machines are subject to wear—yet responsive to care. Good maintenance is doubly important today. There's nothing like stitch-in-time inspection to help obtain the long life built into your "Caterpillar" equipment. Call in your "Caterpillar" Dealer. Let him rebuild parts before excessive wear makes them unsalvageable.

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Oilfield Engines

Effect of Transient Pressures On Flow Metering

By E. C. FITCH, JR.
Research Engineer, Carter Research Laboratory, Tulsa

and

HARRY M. WYATT
Sales Engineer, Valve Engineering & Development Company, Tulsa

PULSATING PRESSURE surges cause flow measurements to record higher values than the true flow through a pipe line. The authors advance a simple theory and mathematical means of calculating the percent of error.

PRESSURE surges in pipe lines produced by a pump or fast-closing valve can produce errors in measurement instruments and the valves controlled by instruments.

When a surge wave is produced, a state of steady flow cannot exist in the pipe line affected, because at any given point pressure and velocity are continually changing. The manner in which pressure and velocity change depends upon the complexity of the surge wave produced in the system. Elimination of pipe line transient pressures is important because any amount of deviation from steady flow conditions has a direct effect on the validity of flow formulas based on Bernouilli's Equation and the Continuity Equation.

In any pipe line, the true rate of flow is the instantaneous rate of flow. The recorded rate of flow, as obtained by the mean differential head between the upstream and downstream ports of an orifice meter, produces a value in excess of the true value as shown by Figure 1. This statement is true if the wave form is sinusoidal in character with all secondary and reflecting waves neglected; furthermore, the recording instrument must be sufficiently damped to give true average differential head.

The common expression for the recorded rate of flow is generally written

$$Q_r = CA\sqrt{29h_m}, \qquad \text{I}$$

where: C is the restriction coefficient,
A is the area of the restriction,
g is the gravity constant, and
h_m is the mean differential head between the upstream and downstream ports of the recording instrument.

The mean differential head can be expressed mathematically by the expression

$$h_m = \frac{1}{2\pi}\int_0^{2\pi} h\,dt, \qquad \text{II}$$

where: h is the instantaneous differential head.

It is reasonable to assume that the instantaneous rate of flow Q is made up of the true mean rate of flow Q_m plus the superimposed sinusoidal wave, Q_o sin wt. Also, the instantaneous rate of flow can be set equal to the expression $(C\,A\,\sqrt{2gh})$ if the instantaneous differential head is substituted for h,

$$Q = (Q_m + Q_o \sin Wt) = CA\sqrt{2gh} \qquad \text{III}$$

Solving for h in Equation III and substituting this for the h in Equation II gives for h_m, after integrating,

$$h_m = \frac{Q^2_m + \frac{Q^2_o}{2}}{2gc^2A^2}. \qquad \text{IV}$$

If the mean differential head is solved for in Equation I and the resulting equation set equal to Equation IV, the following equation results:

$$Q^2_r = Q^2_m + \frac{Q^2_o}{2}. \qquad \text{V}$$

Dividing through by Q_r^2 and rearranging the terms of the equation gives,

$$\frac{Q_m}{Q_r} = \sqrt{1 - \frac{1}{2}\left(\frac{Q_o}{Q_r}\right)^2}. \qquad \text{VI}$$

This final equation is of the form $(y = \sqrt{1 - \tfrac{1}{2}x^2})$, an ellipse, that can be plotted giving a graphical relationship that is easily analyzed.

From Figure 2, it can be seen that if there were no pulsations in the line, the value of the sinusoidal flow Q_o would be zero and the true mean rate of flow Q_m would be equal to the recorded rate of flow Q_r. If the pulsations were extremely large, it would be possible for the recorded rate of flow to be off by as much as a factor of 10.

Since the rate of flow varies as the square root of the pressure, as is evident by equation I, the ratio Q_o/Q_r can be determined. By referring to Figure 3, the ratio can be approximated by taking the square root of the pressure amplitude as measured by a transient pressure device divided by the square root of the damped pressure given by the meter.

The theory advanced above can be more clearly understood if a hypothetical illustration is presented. In a pipe line operating at a recorded damped pressure of 500 pounds per square inch, and pressure pulsations with a magnitude of 100 psi which is equal to an amplitude of 50 psi, the $\sqrt{P_o/P_r}$ ratio would be $\sqrt{50/500}$ or .316. Using this value for the ratio Q_o/Q_r, the corresponding value of Q_m/Q_r from Figure 2 would be approximately 0.96. In brief, the recorded value of the rate of flow would be about 4 percent higher than the true value.

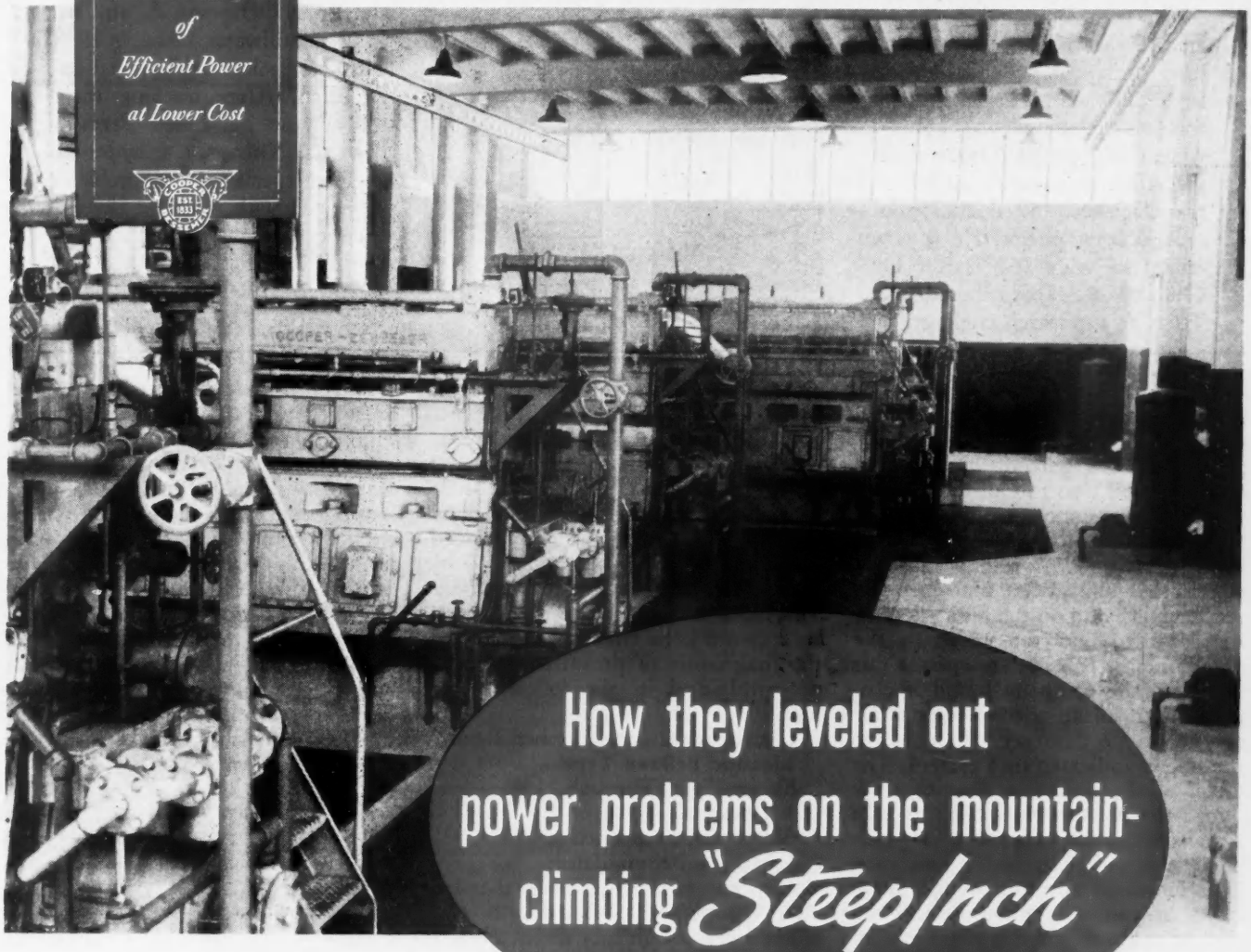
In order to give proof that a pipe line condition as outlined in the preceding paragraph could actually prevail in practice, the following is an example of an actual situation that has been reliably reported as existing in a cycling plant operated by a major oil company located in the Texas Panhandle. The plant under question is a raw natural gasoline cycling plant with a daily production of 115,000 gallons. This production is distributed to a treater by means of a triplex controllable capacity pump running at a rated speed of 225 revolutions per minute. The pump has three-inch diameter plungers, a 0-6 inch variable stroke, and is powered by a 1750 rpm electric motor geared to the pump.

The maximum allowable operating pressure of the pump is 850 psi and the minimum allowable pressure is 190 psi. The recorded operating pressure of the pump is 225 psi. The pressure pulsation produced by the pump and as recorded by a transient pressure device was 25 psi.

A series of tests conducted by the personnel associated with the company

Another Example of Efficient Power at Lower Cost

Three of five Cooper-Bessemer JS-8 diesels, rated 580 hp at 450 rpm, in the Catia de la Mar pumping station of the new Tacagua petroleum products line.



How they leveled out power problems on the mountain-climbing "Steep Inch"

WHAT with grades up to 45 per cent, it's no wonder the Tacagua products line is nicknamed the "Steep Inch." This new line, joint project of Creole Petroleum Corporation and Shell Caribbean Petroleum Company, rises sharply from sea level at Catia de la Mar, reaches a crest of 3,200 feet over mountainous terrain, and terminates at Caracas.

In a project like this, reliable, trouble-free power is more than ever a matter of prime importance. They played safe on this problem — picked Cooper-Bessemer diesels to do the job. The three 580 hp Cooper-Bessemer JS-8's shown above are driving pumps. Two more JS-8's drive generators for electric power requirements. They are the kind of engines you can count on for diesel performance at its best . . . any time, any place, in any service.

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About the Authors

ERNEST C. FITCH, Jr., received both B.S. and M.S. degrees in Mechanical Engineering from Oklahoma A. and M. College, Stillwater. His interest in transient pressures was aroused while doing graduate research on the effect of pressure surges on the efficiency and operation of reciprocating pumps. He is now associated with The Carter Oil Company Research Laboratory at Tulsa as a research engineer.

Fitch

Wyatt

HARRY M. WYATT graduated from Oklahoma A. and M. College, Stillwater, Okla., in 1948 with a B.S. degree in general engineering. After teaching there for a year he joined Perrault Brothers, Tulsa, as a hydraulic engineer specializing in problems connected with pipe line desurgers and plastic pipe. He is a veteran of World War II and was recently recalled to duty with the U. S. Army, Corps of Engineers.

operating this plant showed that the 25 psi pressure pulsation caused the orifice recording meter to read approximately 10 percent higher than the measured true rate of flow.

It was very important for the company operating this cycling plant to know the true flow rate because of contractual obligations that involved settlements based on the indications of the recorded flow rate given by the orifice meter. In order to correct this situation, the company found it economical to install a conventional air chamber type desurger at a point in the line as indicated by Figure 4. The effect of the pulsation dampener reduced the pressure fluctuation and in turn substantially improved the percent error in the recorded flow rate. This increased accuracy of the measuring instrument through the reduction of pressure surge is definitely indicated by a close analysis of Figure 2.

It has been shown that an important step in approaching the true measured rate of flow in a pipe line is the reduction of pressure surges. In order to accomplish this step, the selected dampener should be properly placed in the pipe line as recommended by reliable manufacturers of desurgers. The types of surge removers that have been found to be effective in reducing the magnitude of pressure pulsations are included in the following examples:

Conventional Air Chamber Type
Metallic Bellows Type
Sleeve Type Through-Flow-Desurger
Sleeve Type Appendage
Bag Type Accumulator

Before any of the above listed pulsation dampening equipment is considered for use in any application, it is suggested that the manufacturer be consulted and the encountered problem be thoroughly analyzed.

It cannot be overemphasized that the theory presented in this discussion is applicable to a pipe line where sinusoidal waves are prevalent. This wave form, while not too common in the field, is produced by a single-acting simplex pump. Since all complex waves can be reduced to a series of simple sinusoidal waves, a similar mathematical approach as used in this discussion can be developed to correct recorded flow rates in lines with complex pressure waves.

ACKNOWLEDGMENTS

The writers are indebted to Edward F. Johnson of the Carter Oil Company Research Laboratory for his assistance in presenting the mathematics and also to L. W. Ledgerwood, Jr. of the Carter laboratory for proofreading the article and making valuable comments. Material contained in this article is not to be attributed to The Carter Oil Company.

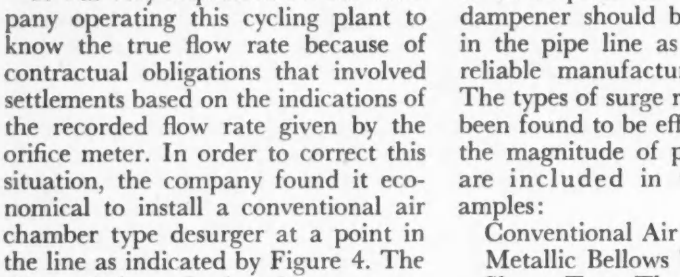


FIGURE 1.

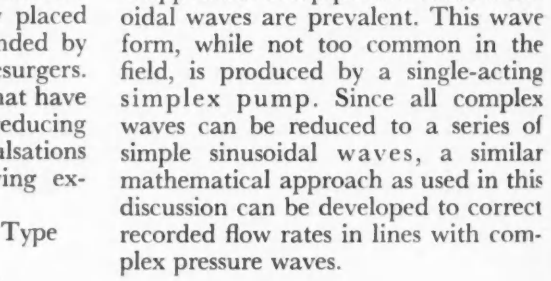


FIGURE 4.

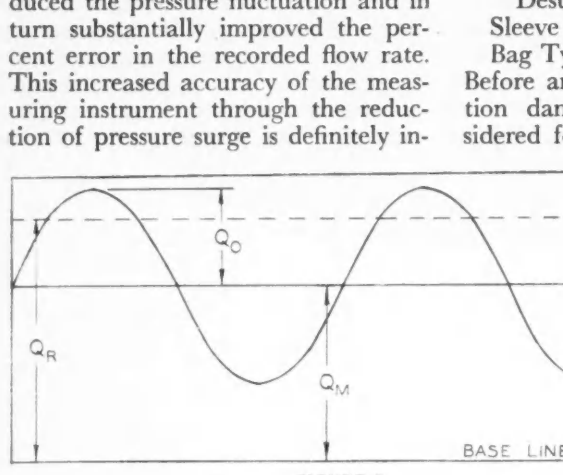


FIGURE 2.

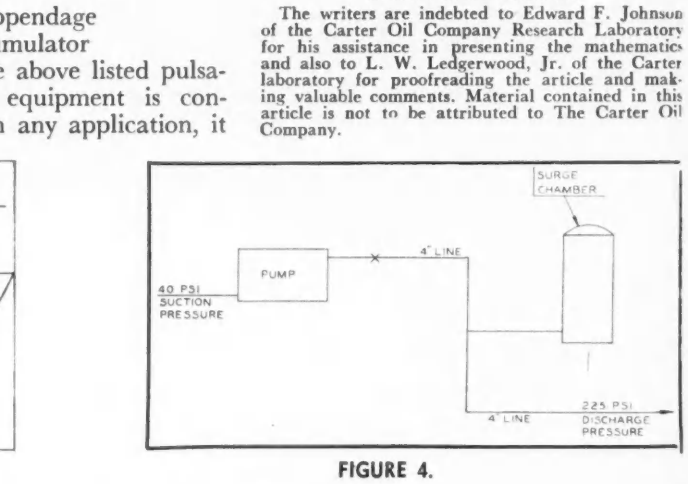
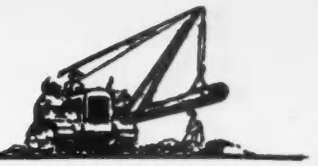


FIGURE 3.

PIPE LINE *Construction*



By CECIL W. SMITH, WORLD OIL Staff

Projects Announced and Contracts Awarded

Crude Lines

Atlantic Pipe Line Company has Petroleum Administration for Defense approval for the construction of 30 miles of 6-inch pipe line to run from the South Ward field, Ward County, to Atlantic's Crane station, Block 31 field, Crane County, West Texas. Capacity of the new line would be 15,000 barrels per day. It is understood that the line would be built of salvaged pipe.

Humble Pipe Line Company has plans for early 1952 construction of 30 miles of 12-inch line to run from the Pembrook field, Upton County, to its Kemper station, Reagan County, West Texas.

Texas-Empire Pipe Line Company has announced its intention to build 30 miles of 18-inch pipe line between Wilmington and Lockport, Ill. Construction will probably get under way about the first of August, 1952.

The Texas Pipe Line Company has awarded a contract to Houston Contracting Company, Houston, for the construction of 220 miles of 22-inch pipe line to run from Houma, La., to Port Arthur, Texas, and 31 miles of 12-inch line from Cocodrie, La., to Houma. Included in the job will be 60 miles of 6 to 10-inch gathering system in Bay St. Elaine, Lake Barre, Lake Pelto, and Caillou Island fields in the Terrebonne Bay area.

Natural Gas Lines

Atlantic Seaboard Corporation has asked FPC for permission to build four new compressor stations with a total of 18,200-hp, and to add 1100-hp to an existing station on its Cobb (W. Va.)-Rockville (Md.) 26-inch line. Sites of the new stations would be in Braxton, Upshur, Pendleton, and Hardy counties, and the additional power would be put into the Files Creek station. All construction would be in W. Va.

Central Illinois Public Service Company has made application to the FPC for permission to install 12.7 miles of 6-inch pipe between Panhandle Eastern Pipe Line Company's line to Paris, Ill.

Georgia Gas Company has received authorization from FPC to build 32 miles of 4-inch pipe line from Transcontinental Gas Pipe Line Corporation's line near Bogart, Clarke Co., Ga., to Gainesville, Ga.

Indiana Gas and Water Company has asked FPC for permission to build a 19-mile 8-inch loop on the line from Panhandle Eastern's main line to Crawfordsville, Ind., and a 13-mile 6-inch loop from Panhandle Eastern's line to Lebanon, Ind. The lines to be looped are owned and operated by Panhandle Eastern.

Mississippi River Fuel Corporation has received temporary authorization from FPC to construct 13 miles of 12-inch line from the Sligo field, Bossier Parish, N. La., to the Barksdale gunnery and bombing range.

Missouri Central Natural Gas Company has awarded a contract for the construction of 30 miles of 6-inch pipe line near Macon, Mo., to the L. R. Young Construction Company, Olney, Ill. The job will start early in 1952.

Montana-Dakota Utilities Company has FPC authorization for the laying of 8½ miles of 4-inch line from General Petroleum Corporation's line in Washakie County, Wyo. to the company's Worland compressor station in the same county.

New York State Natural Gas Corporation has been authorized by FPC to build a 3080-hp compressor station in the Leidy gas field, Clinton County, Penna.

Petroleos Mexicanos plans to build 435 miles of 20-inch natural gas pipe line from Brazil, on the Texas-Tamaulipas border, to the Posa Rica field, Vera Cruz, Mexico. The $11.4 million project is being planned for early 1952 construction. The gas from this line will be used to repressure the producing sands of Posa Rica, Mexico's finest field. It has been estimated that repressuring will increase the field's output about 60,000 barrels per day.

Southern California Gas Company has FPC authorization to build 38 miles of pipe line from Pacific Gas & Electric's existing line near Mojave to Palmdale, Calif.

Southern California Gas Company & Southern Counties Gas Company has been given permission by FPC to lay 23½ miles of 30-inch pipe from Inglewood to Los Angeles, Calif. Project will increase capacity from the La Goleta storage field to Metropolitan Los Angeles.

Texas Gas Transmission Corporation has made application to FPC for a permit to build 407 miles of 26-inch loop lines between Bastrop, La., station to its Hardinsburg, Ky., station. Included in the petition is the addition of 26,860-hp in existing compressor stations. This request is substantially the same as one denied earlier by FPC.

United Gas Pipe Line Company has asked FPC to permit the installation of 11.3 miles of 20-inch pipe from the Kent Bayou and Turtle Bayou gas fields, Terrebonne Parish, to United's 24-inch line under construction in Terrebonne Parish.

West Texas Gas Company is seeking FPC permission to lay 30 miles of 22-inch loop line south of its Turkey Creek station in Potter County, Texas Panhandle. The company also wants to install additional 1350-hp at the Turkey Creek station and 660-hp in McSpadden station in Randall County.

Projects Starting

Crude Lines

Phillips Pipe Line Company has started 68 miles of 10-inch crude line between El Dorado and Osawatomie, Kans. Brown Lite Company, Tulsa, is the contractor. This project is a section of the 281-mile line running from the Texas Panhandle to Yale, Okla.

Service Pipe Line Company started 12 miles of 6-inch and 3 miles of 4-inch line from the new crude producing area near Tioga, N. D., to a new 12-car loading rack in Tioga. Vaughn & Taylor Construction Company, Tulsa, has the contract.

Sinclair Pipe Line Company has started construction on its new 675-mile 22- and 24-inch crude carrier from Drumright, Okla., to East Chicago. A 154-mile 24-inch section from Drumright to Humboldt, Kans., has been started by O. R. Burden Construction Corporation, Tulsa. The line will be 24-inch to Salisbury, Mo., before reducing to 22-inch.

The Texas Company has Midwestern Constructors, Inc. ,Tulsa, at work on 5.9 miles of 26-inch and 4 miles of 24-inch line in Marion County, Ill.

Product Lines

Colombian Government has started 111 miles of 6-inch product line running from Puerto Berrio to Medellin. The line is being built by the Carolina Constructors of Texas, Inc., Houston. Puerto Berrio is located on the Magdalena River, and the entire line will be laid in the Department of Antioquia.

Gulf Oil Corporation has started 31 miles of 6-inch line from Texas City to La Porte, Upper Texas Coast, Barry Construction Company, Houston, is doing the job.

Socony-Vacuum Oil Company, White Eagle Division, has started take-up, recondition, and relay of 175 miles of 6-inch line from Augusta, Kans., to Kansas City.

Natural Gas Lines

Houston Pipe Line Company began work during December on 25 miles of 24-inch line between Alvin and Texas City, Texas. Brown & Root, Inc., Houston, is doing the construction.

Magnolia Petroleum Company expects to get started in December on a 78-mile gathering system in the Pegasus field, Midland and Upton counties, West Texas.

Manufacturers Light & Heat Company has started 20 miles of 12-inch line in Center and Cameron counties, Penna.

Britton Contracting Company, Inc., Washington, Penna., is the constructor.

Ohio Fuel Gas Company has started construction of 25 miles of 20-inch pipe line from its Howell station to Xenia, Ohio. This project is being built by Sheehan Pipe Line Construction Company, Tulsa.

Southern Union Gas Company had R. H. Fulton & Company, Lubbock, Texas, start work on 30 miles of 20-inch pipe line in the vicinity of Farmington, N. M., early in December.

St. Charles Pipe Line Company in December started 30 miles of 12-inch line from the St. Charles gas field, Aransas County, to the new Reynolds Metals Company's plant near Gregory, San Patricio County, Southwest Texas. Altgelt Construction Company of Corpus Christi is the contractor.

Union Gas & Electric Company started early in December on 32 miles of 8-inch line from the Texas-Illinois Natural Gas Pipe Line Company line near Farmer City, Piatt County, to Bloomington, Ill. Contracting & Material Company, Evanston, Ill., is doing the job.

Projects Completed

Crude Lines

Ohio Oil Company expects to complete its 20- and 22-inch crude carrier from Wood River, Ill., to Lima, Ohio, by the end of the year. The last leg is in the final stages of completion and should be completed by year's end. That section is 117 miles of 22-inch pipe from Sheridan, Ind., to Lima, and is being laid by Conyes Construction Company, San Pablo, Calif. The first 54 miles of 20-inch line from the Wood River end was built by Bechtel Corporation, San Francisco, and was completed soon after the first of 1951. From Patoka, Ill., to Sheridan 74 miles of 20-inch and 98 miles of 22-inch pipe were laid by Conyes and that section was completed in June, 1951.

Service Pipe Line Company expects to complete by the end of the year 12.8 miles of 20-inch loop from La Plata, Mo., to a point west of the Chariton River in Macon County, Mo., and 16.8 miles of 20-inch loop line from Odessa Junction, Lafayette County, Mo., to Pleasant Hill Junction in Cass County. G. G. Griffis Construction Company, Inc., Tulsa, is handling both jobs.

Product Line

Phillips Petroleum Company completed 40 miles of 10-inch line between California, Mo., and Bay, Mo. Trojan Construction Company, Inc., Oklahoma City, constructed the line.

Natural Gas Lines

Central Kentucky Natural Gas Company expects to complete by the end of the year 13 miles of 20-inch line running northwestward from North Means, Ky. The job was done by L. R. Young Construction Company.

Consolidated Gas Company completed 30 miles of 10-inch pipe line in the Duncan, Okla., vicinity. The line was laid by Jim J. McCormick & Company, Wichita Falls.

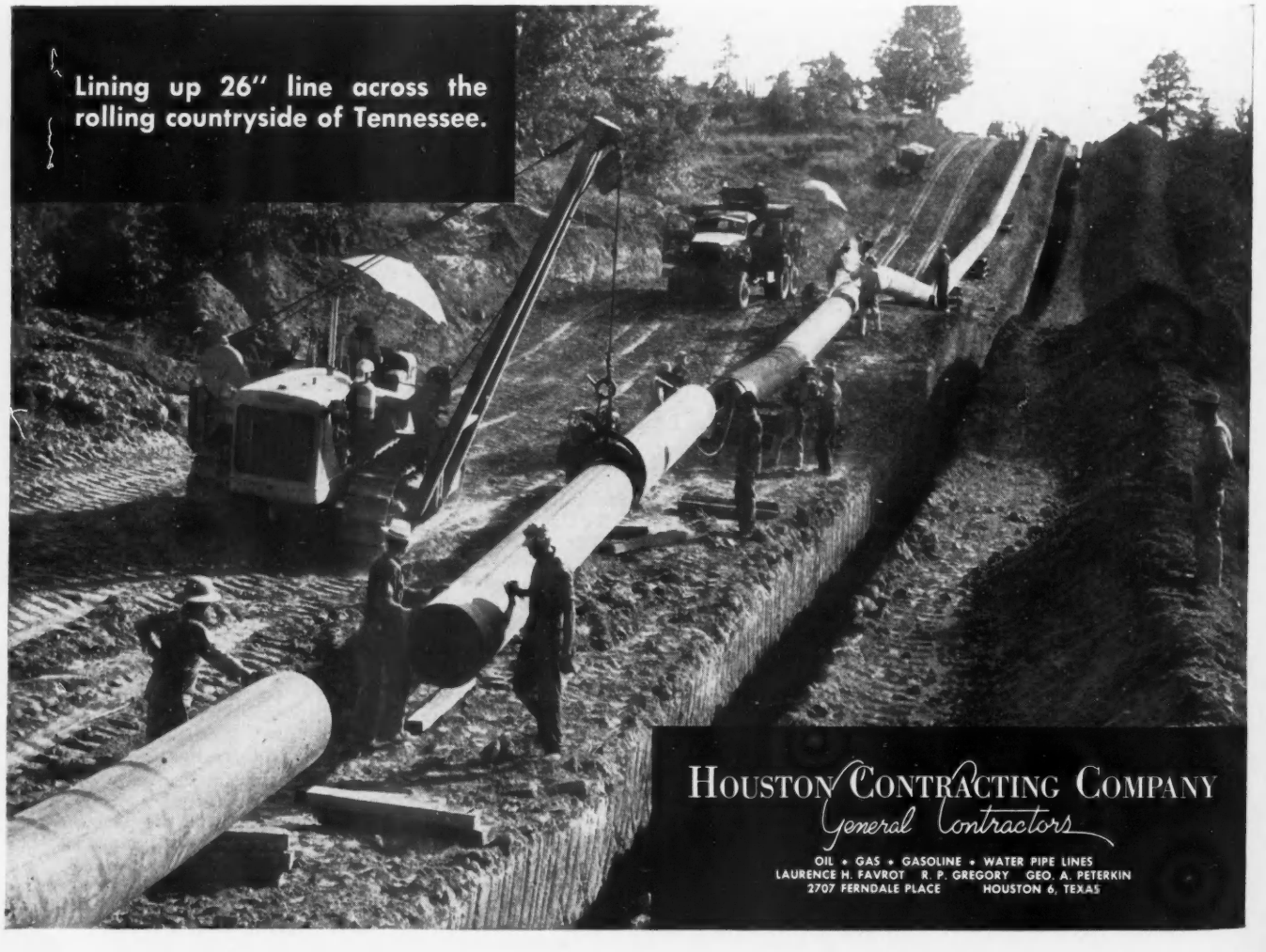
Ohio Fuel Gas Company has completed 23 miles of 16- and 20-inch line between Wellington, Lorain County, to Parma, Cuyahoga County, Ohio. H. L. Gentry Construction Company, Jackson, Mich., was the contractor.

Texas Eastern Transmission Corporation expected to complete by the end of the year 76 miles of 30-inch line between Florence, Ala., and Columbia, Tenn. Eastern Pipe Line Contractors, Dallas, constructed the line.

Texas Eastern Transmission Corporation also expects to complete by the end of the year 163.6 miles of 30-inch line from Koscuisko, Miss., to Florence, Ala. The contractor on this section was Williams Bros.-Davis Company, Houston.

United Carbon Company, Inc., has completed 24 miles of 4- through 14-inch gathering and transmission system from the Fulton Beach field, Aransas County, to the company's carbon black plant south of Rockport, Southwest Texas.

Wisconsin Power & Light Company completed 20 miles of 6-inch gas line from Ripon to Fond-du-lac, Wisc. Somerville Construction Company, Ada, Mich., laid the pipe.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Electric Resistance and Fusion Weld—Plain End	8⅝" to 20" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser
Electric Resistance Weld—Plain End	5 5/16" to 12¾" O.D.	Up to 55'	.188" to .400"	Fontana, Calif.
Electric Fusion Weld—Expanded—Plain End	22" to 30" O.D.	Up to 40'	.188" to .500"	Napa, Calif.—Basalt-Kaiser

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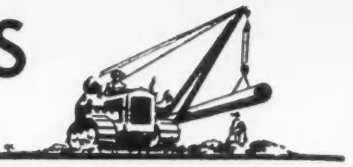

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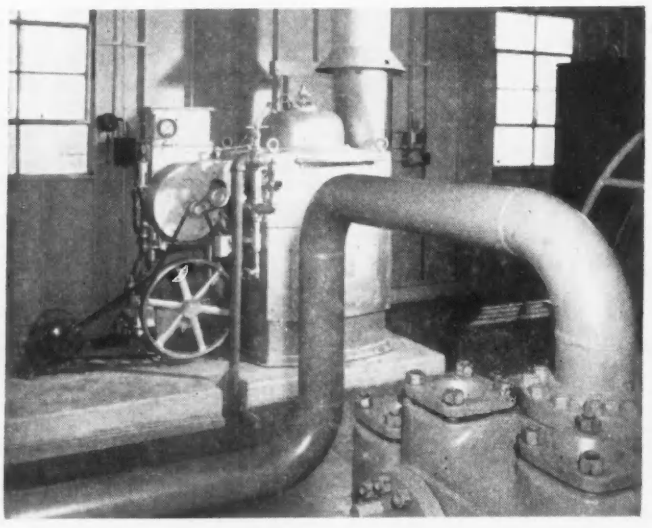
HOW TO—Increase Pump Efficiency



One company increased pumping efficiency at its pipe line terminal by installing a small portable boiler to heat crude through a heat exchanger, lowering viscosity and saving money in loading tankers.

Because the time tankers are in port is charged against terminal activities, it is important that the loading operation consume the shortest possible time. In this installation, pump suction was sluggish, fed by gravity from nearby storage tanks.

Capacity was increased when the company installed a 100 horsepower boiler which can evaporate 3200 pounds of feed water per hour into 460° F. steam. Through a small heat exchanger the stream raised the temperature of crude, lowering viscosity to increase flow to the pump.

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Prior to setting the pump, a channel is formed by welding 1½-inch angle iron around the base of the pump, to form a channel sloped toward one low point. A hole is cut in the channel at the low point to allow a suitable length of drainage pipe to extend through the opening when the pump is set on the foundation for grouting. This drainage line is located in the pump foundation prior to pouring and it leads to a separator or sump.

After the pump has been leveled and grouted, the drainage pipe is cut flush with the bottom of the channel and a cold welding pass is applied to prevent leakage.

This type installation has many advantages over the conventional drainage channel formed in concrete because most petroleum products have an undesirable effect on concrete.

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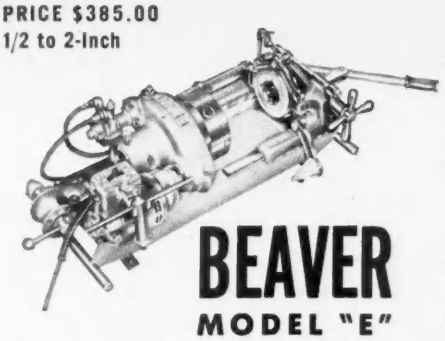

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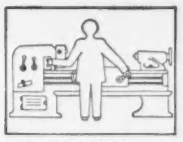

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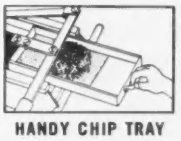

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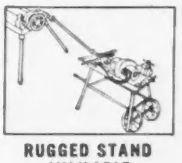

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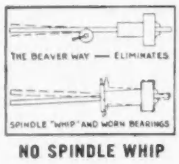

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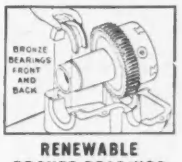

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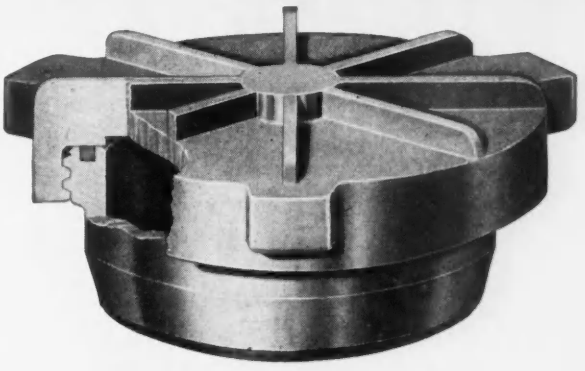

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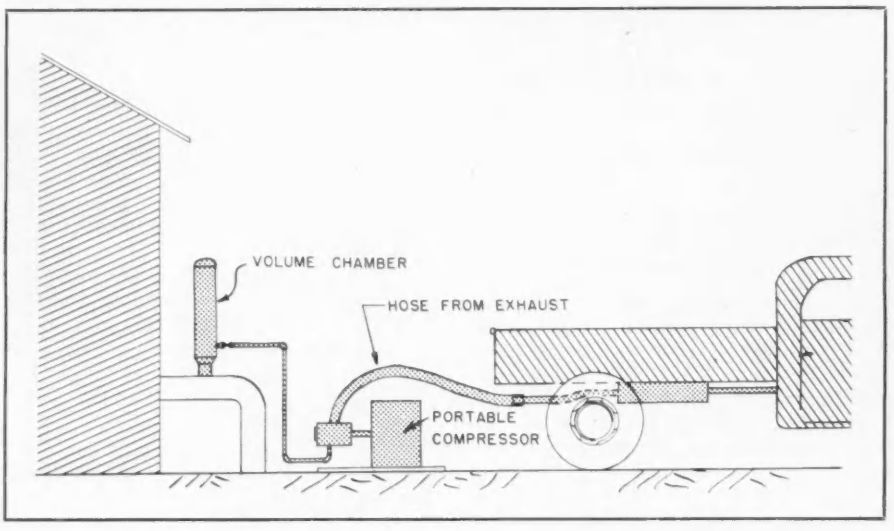
HOW TO—Fill Volume Chamber



The possibility of explosions in volume chambers was eliminated on a crude oil-propane line by filling them with exhaust gases from a truck rather than with air.

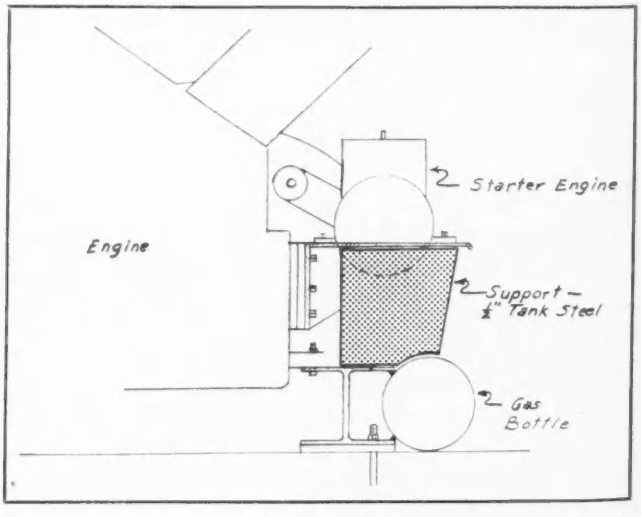
Since propane, as well as vapor from unstabilized crude, will readily vaporize to form explosive concentrations when mixed with air, the volume chamber should be filled with inert gas. If hydrocarbon vapor and air ratios reach explosive range, a sudden pressure surge can cause a diesel-type explosion.

The use of bottled inert gas proved expensive since pipe line fluid absorbs gas from the chamber as it surges.

An inexpensive means of filling the volume chambers with inert gas was devised by field forces. The exhaust of a pipe line truck was hooked to the suction of a small reciprocating compressor which discharged into the volume chamber as shown.

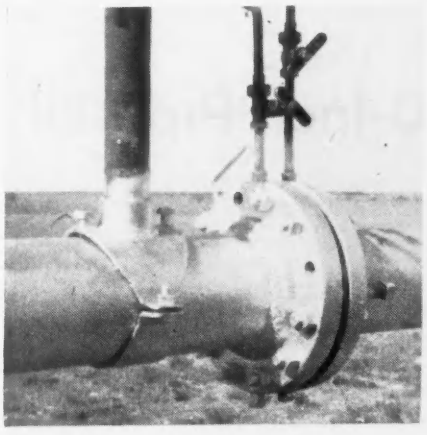
HOW TO—Add Starter Engine Brace

Using two square feet of one-half inch steel plate and a few hours of a welder's time, one company overcame repeated fractures occurring in a starter engine mount on large gas engine driven pump.



The pump engine vibrations were magnified when reaching the starter engine (Power-Fulcrum-Weight principle) and fractures repeatedly occurred in the L-shaped starter engine support. The excess vibration was also adversely affecting the starting engine.

Two 10 x 8-inch supports cut from half-inch steel plate were welded to bottom of the existing starter engine bracket and to the pump engine skid. Vibration was reduced and no additional fractures appeared.



HOW TO—

Clamp Meter Stand Support Onto Line

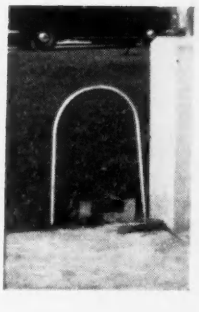
A meter stand support which fastens directly onto the meter run can be easily fabricated from a short length of scrap pipe, two cap screws and two small stud bolts with hex nuts.

A half coupling which fits the meter stand is welded as shown to a clamp made of pipe one size larger than the meter run. When bolted around the pipe, the clamp is thus slightly larger than the meter run. It is tightened in place by the two cap screws at the top. The cap screws also aid in leveling the meter, by permitting the stand to be tiled forward or backward. Total expense of the clamp should not exceed $2.

HOW TO—

Make Safety Guard Over Foot Scraper

By installing a U-shaped piece of ¾-inch galvanized pipe over a foot scraper at a pump station, accidents were eliminated and the presence of a foot scraper was emphasized for benefit of visitors.



Almost every entrance to pump buildings is equipped with a foot scraper. The sharp metal surfaces offer a safety hazard, which can be easily overcome by installing the inexpensive length of pipe over the top and painting it a bright color.

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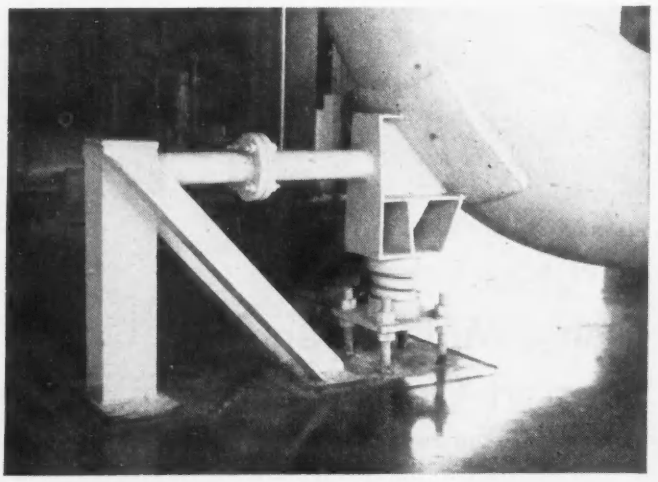
HOW TO—Support 30-Inch Pipe Ell



A simply-constructed pipe hanger supports a 30-inch riser at the ell and prevents horizontal movement which would transmit torque of great force to a centrifugal compressor.

The pipe hanger is readily demountable, easily adjusted, and easily constructed. A foundation for the hanger was poured separate from the compressor building basement, divided from the floor by a mastic expansion material. Bolts for the spring loaded pipe support and bearing plates were poured as integral part of the foundation.

A six-inch vertical H-beam stands about two feet above the floor braced with three-inch angle iron as shown. Three-inch pipe ties through a flange to the built-up section, welded to a pad on the 30-inch ell.

Weight of the riser is supported by a heavy coil spring mounted on a bearing plate which can be adjusted by hex nuts on anchor bolts. The entire installation is readily demountable.

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HOW TO—Expedite Concrete Pours

One company attached a one-quarter yard concrete bucket with shop-made flexible pouring spout to a hydraulic front-end lift mounted on a small tractor to speed small concrete pours on a station construction job.

The rig shown in the picture eliminated the necessity of moving concrete mixers, aggregate and cement from place to place on the job or moving concrete in wheelbarrows when pouring small piers and footings. From central mixing stations, the concrete was distributed to small foundations.

The hydraulic lift and concrete bucket were mounted on the tractor frame. The pouring spout was fabricated by riveting old fire hose together. This spout prevents separation of concrete when it is poured.

Significance of Cretaceous Oil Discoveries in Central Alberta

By C. WARREN HUNT
Chief Geologist, Pan Western Oils, Western Homestead Oils, and Long Island Petroleums, Calgary, Alberta

OIL in the Central Alberta plains is found in Cretaceous or Devonian sedimentary strata. Devonian limestones are covered throughout the central plains by 2000-4000 feet of Cretaceous sands and shales with a normal monoclinal southwest dip of about a half degree. The Devonian contains about 95 percent of present day known oil reserves. The Cretaceous sand reservoirs contain some five percent of known reserves.

Devonian production is from reef dolomites. Cretaceous production is entirely from sands. Eight large reef fields account for the bulk of the Devonian reserves: Redwater, Leduc, Golden Spike, Wizard Lake, Camrose, Acheson, Stettler, and Big Valley. Cretaceous oil reserves are found in about 35 small sand fields, largest of which are Joseph Lake, Campbell and Lloydminster.

Cretaceous gas fields are far more abundant and prolific than the oil fields. Where a large Devonian reef field may contain 800 million barrels of recoverable oil, the largest Cretaceous sand field known in central Alberta contains only about 15 million barrels. It is not surprising that the attention of oil companies is centered on the Devonian.

Prior to the postwar development of oil and gas reserves in Alberta, the Cretaceous was generally regarded as the most favorable and the only known productive prospect in the central plains area.

It is noteworthy that the Southern Alberta and Montana oil reserves discovered have been largely Cretaceous and Mississippian. Rocks of these two ages contain approximately equal portions of the total reserves of Montana, while the now-depleted Turner Valley reserve caused the Mississippian to predominate Southern Alberta.

Fluctuating interest in oil in the central plains occurred after the discovery of the Wainwright and Vermilion fields during the 1920's and 1930's. Imperial Oil Limited is reported to have been primarily interested in Cretaceous oil production in the drilling of Leduc 1 in 1947. That well is said to have proceeded into the Devonian as a secondary objective after failing to find Cretaceous oil production.

OVER THE central plains of Alberta new Cretaceous discoveries will be made by wildcatting, drilling for deeper horizons, or through subsurface geologic studies. If Cretaceous sand fields of today are indicative of future reservoirs which may be found, new discoveries will have producible reserves up to 25 million barrels. This paper, to which additional information and charts were added, was originally presented at the 1951 annual western meeting of the Canadian Institute of Mining and Metallurgy October 3-5, 1951, at the Palliser Hotel, Calgary, Alberta.

During the years following the Leduc discovery only slight attention was paid to the Cretaceous. Many small Cretaceous discoveries were made, however, several of which have developed into profitable though relatively small oil reservoirs. Many more proved non-commercial.

Types of Oil Fields

There are at least three different and important kinds of Cretaceous fields in the central plains region. Table 1 shows characteristics features of the three largest: the Campbell, Joseph Lake and the Lloydminster fields.

Campbell field is typical of production from the Ellerslie sand or its equivalent in the Blairmore formation. Other fields of this type are Whitemud, Ellerslie, Gilbert, North Woodbend, Stony Plain Cretaceous, Stettler Cretaceous, and numerous other one-and two-well fields in the general Edmonton area.

Joseph Lake is the largest, and by far the most important, Viking sand oil field in Alberta. The only other Viking fields are of small importance —the Anglo Canadian Camrose field and the Lisburn Viking well.

Since the writing of this paper, a new Viking discovery has been made at Armena southeast of Joseph Lake. This new field may be of considerable significance and could develop into another Joseph Lake type accumulation.

Lloydminster field is a composite group of very small lower Cretaceous productive areas. The term "Lloydminster field" is applied for geogra-

TABLE 1
Typical Cretaceous Oil Fields of Central Alberta

	CAMPBELL	JOSEPH LAKE	LLOYDMINSTER
Producing Formation	Blairmore formation Ellerslie Member Four sand zones.	Colorado formation Viking Member One zone lying twenty-two feet below top of Viking.	Blairmore formation Sparky, Lloydminster and Unity sand zones.
Approximate Depth	3700 feet	3200 feet	2000 feet
Gravity in Degrees, A.P.I.	29-35°	36-38°	13-16°
Average Pay Zone Thickness	22 feet	13 feet	15 feet
Average Porosity	19 percent	25 percent	23 percent
Production Difficulties	1. High solution gas. 2. Waxing up of tubing and flow lines.	1. Gas and water coning necessitate workovers for squeezing, etc.	1. Sand influx. 2. High viscosity of oil causes flow line plugging.

phic rather than geologic reasons. Other fields of this type are Vermilion, Baxter Lake, Wainwright, Bonnyville, Dina, etc.

Attention is called to a significant comparison of these three field types. Campbell and Lloydminster produce from the lower Cretaceous Blairmore formation, while Joseph Lake produces from the upper Cretaceous Viking sand. All three produce from traps in which permeability barriers rather than structures are the primary trapping factors. Structural features are found to modify the reservoirs locally. Gravities of the Campbell and the Joseph Lake oils are nearly identical, while Lloydminster gravity is considerably lower. Thickness of productive interval is less at Joseph Lake than in the others, while porosity conditions are approximately the same for the three.

Production of the Campbell field type in the general Edmonton area often gives much trouble due to high gas-oil ratios and accumulation of wax in the tubing. High gas-oil ratio is due mainly to a high solution gas content and, therefore, rises with depletion of the field. An example of a field with these difficulties is the Whitemud field in which production is materially curtailed.

Problems at the Joseph Lake field are of a type to be expected from a relatively thin productive zone and high porosity and permeability—that is, influx of gas and formation water. These conditions are causing some trouble and workover jobs.

In the Lloydminster field, low gravity and higher viscosity cause much sand trouble. Sloughing of bottom hole formations tends to permit water or gas to enter the well and to decrease oil production. Sand in the fluids produced causes trouble with pumping equipment.

At Campbell and Joseph Lake, most wells flow from the beginning though some have pumps installed immediately—a practice believed to increase well life and to reduce the need for workovers. Lloydminster field wells never flow because of low gravity, high viscosity and lower solution gas content of the oil.

Generally speaking, all Cretaceous wells in Central Alberta have thin productive zones, varying from 10 to 30 feet in the Lloydminster and Campbell fields and 5 to 20 in the Joseph Lake field. In comparison to sand reservoirs elsewhere, these thicknesses are very low. Ten feet is normally considered marginal.

Higher gravity oils from the Campbell and Joseph Lake type fields command a price of $2.50 to $3 per barrel. Lloydminster crude brings about half this price.

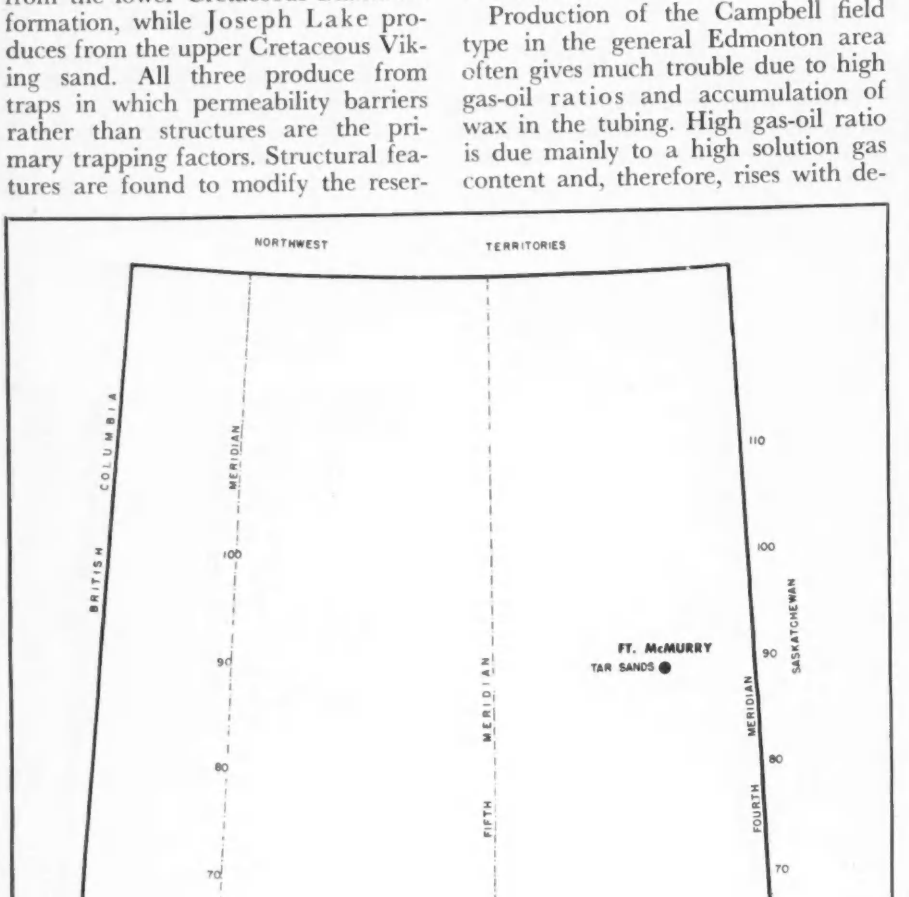


FIGURE 1.

Location of Cretaceous Oil

The most interesting problems related to Cretaceous oil in the central plains of Alberta are: Where will we find more oil and how much may we expect to find?

First, consider values of various oils. A barrel of high gravity oil in place in a Cretaceous sand oil field in the Edmonton region, is worth at least five times that of a barrel of low gravity oil in place near Lloydminster. But the high gravity type is 50-150 percent deeper and may be several times as expensive to locate. The conclusion of most oil men, judging from drilling activity, is that in a proved or semi-proved area either type of production is worth drilling for, but as a wildcat neither is an especially favorable prospect.

A line in Figure 1 separates the area in which high gravity oil of the Campbell and Joseph Lake type is found from that in which low gravity Lloydminster type is found. Oil of the one region on the east has a 10-21 gravity. Oil in the western area has a

32-41 gravity. Apparently they occur in distinctly different areas. In many parts of the world where series of sedimentary strata bear oil one on top of another, each oil may have different gravity, different sulfur content and other different properties. On the Central Alberta plains, however, occurrences of low and high gravity oil types do not overlap.

Occasional examples of medium gravity overlapping are known. One such occurrence is the 29 gravity oil in an upper sand in the Campbell field. Another occurrence is a similar oil in a sand at the Excelsior field. These medium-gravity oils do not compare to the low gravity oils of East Central Alberta.

Second, it seems important and significant that oil found in Cretaceous sands is similar to that found in the underlying Devonian rocks. This is true for both low and high gravity oil; it is true for small showings as well as substantial pools. For example, the Whitemud field produces high gravity oil with qualities almost identical to that produced from the Leduc field downdip. On the other hand, in the eastern area, where 10 to 21 gravity oil is found in the Cretaceous sands, live black oil is frequently found in pores of underlying Devonian rocks. Black oil has not been found in commercial quantities in Devonian reservoirs.

In explaining the division of the central plains into "black" oil and "light" oil regions, geologists, find little apparent east-west variation in the Cretaceous sands and shales. A remarkable difference occurs, however, between the east and the west in the Leduc reef formation or "D-3." Figure 3 shows that all the large transgressive reefs of the Leduc type lie in the western area. These structures grew upward as isolated shoal reefs when the sea deepened. After reaching 600 or 700 feet above their original root bases, most of the reefs were drowned by the transgressing sea. Calcareous clay was deposited continuously over the reef crests and in the intervening miles of open sea. So the reefs became perfect traps and reservoirs for petroleum.

In East Central Alberta, however, a vast shallow shelf of continuous reef material lived and kept up with the transgression of the seas. There were no areas of open sea between reefs. Instead, the whole region was covered by a continuous reef. This "shelf reef formation" was not composed purely of animal organisms, as was the case with the giant reefs to the west. It was composed of biothermal growths with layers of clastics interstratified. Such floods of sand, clay and debris from the reef shelf itself caused repeated interruptions in the growth and development of the bioherms. Individual biohermal growths are quite small as a result.

This phenomenon is an important environmental difference between the eastern and western plains. Under these conditions, would it not be probable that the fauna living in the more turbulent environment would differ from the fauna living in the isolated platform reefs to the west? Would it not be probable that the different faunas would generate different oils? And considering that the line separating the occurrences of "black" oil and "light" oil coincides with the east-west change from the reef embayment to the reef shelf, it is probable that the change in oils is due to the change in reef terrane.

The principal difficulty with this hypothesis of reef origin and migration is the necessary conclusion that low-gravity oil can and does migrate through barriers of dense shale, sandstone and limestone between the source and known occurrences of the oil.

The best answer to this problem is that both light and black oil have been found in positions of apparent migration. Under these conditions is it not reasonable to assume that huge quantities of oil, gas, and water can slowly traverse paths which cannot be detected with laboratory methods? Water, of course, being beneath any oil or gas accumulation, would force all oil or gas ahead of it.

An objection to the Devonian origin for oil in the central plains is that some occurrences of medium gravity oil have been found northwest of Edmonton and east of Stettler. Oils found in the Bulkwark and Borth discoveries east of Stettler are in the 22-23 gravity range, as are other nearby showings.

This oil is similar to the Mississippian oil of the southern part of the province and in Montana. Therefore, since these occurrences lie updip from the truncation of the entire plains section of Mississippian lime-

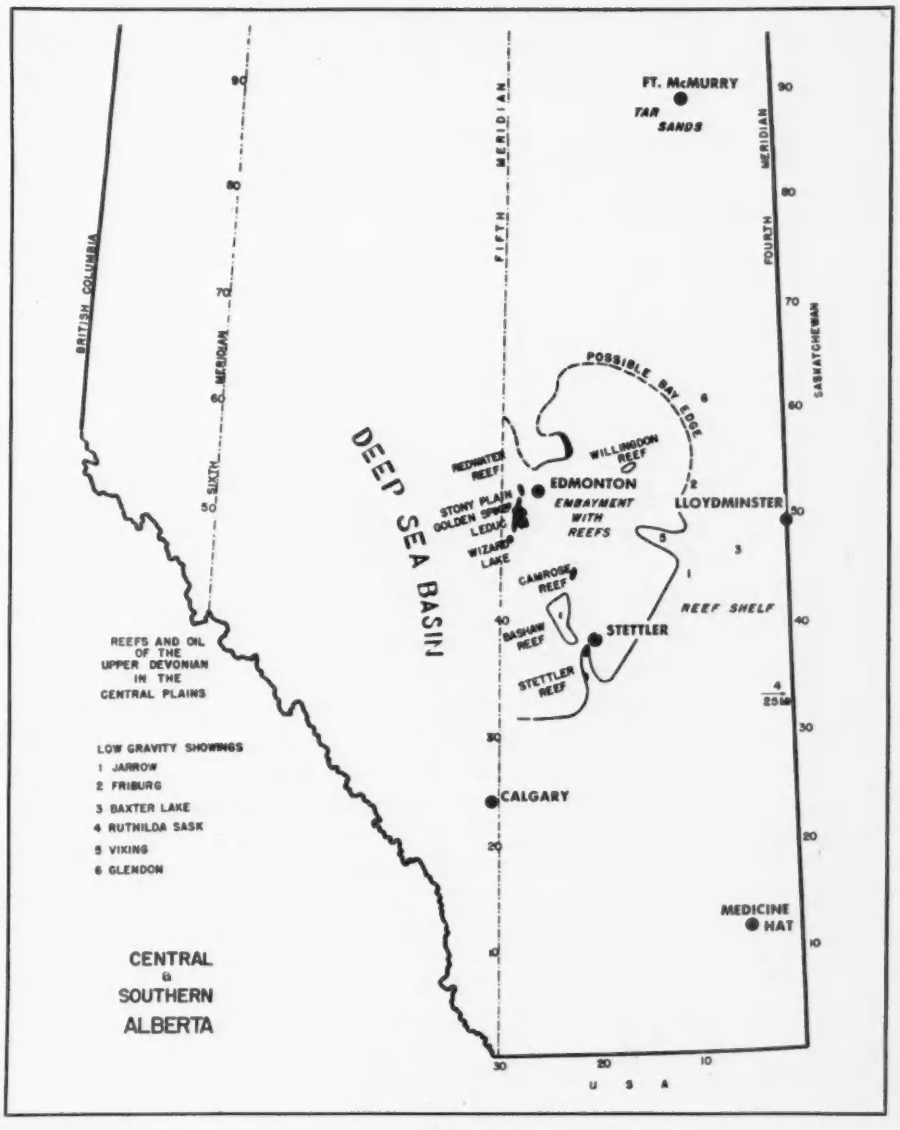


FIGURE 2.

stone, it is likely that this oil originated in the Mississippian and migrated to the Cretaceous.

Several occurrences of 25-29 gravity oil are to be found northwest of Edmonton. Some of these may be related to the Mississippian, but others are awkwardly placed for migration from these rocks. Changes from the upper Devonian reef embayment to another shelf terrane seem to occur in about this area and to continue far to the north and west, probably at least as far as Athabaska and Lesser Slave Lake. The medium gravity oil may be related at least in part to this second Devonian reef terrane. Insufficient exploration has been done, however, to justify a final classification of the reef environment in the general area northwest of Edmonton.

Conclusions

It appears that the valuable high gravity oil found in Cretaceous strata in the general Edmonton-Stettler region is related to a specific upper Devonian terrane. Occurrence of this oil appears to be limited to the area of the reef embayment. Drilling has defined the eastern and southeastern limits of high gravity production at the edge of the reef shelf terrane. There are indications that occurrences of high gravity oil will be limited northwest of Edmonton by a similar phenomenon.

The southwestern limit is set by the occurrence of a substantial section of dense Mississippian shale shielding the Cretaceous sands from the Devonian source beds. The northeast limit remains largely unexplored, although low gravity oil has been sporadically reported in that direction. If the embayment existed, it probably had a northeast border.

There are two well-known important types of Devonian oil occurring in Alberta's central plains. The first, a 10-21 gravity oil, originates in the Upper Devonian shelf reef terrane of the east-central plains and migrates into lower Cretaceous strata. This oil is produced at Wainwright, Lloydminster, Vermilion, etc., and is found as showings in the Devonian beneath these fields and downdip from them.

A second type, 32-41 gravity oil is generated in association with the reef embayment terrane in the western part of the central plains of Alberta and is produced both from the Devonian and from the Lower and Upper Cretaceous sands of that area. Commercial production occurs in permeability traps in the Viking and Blairmore sands. Cretaceous fields may be quite substantial, although they will never compare in quantity of reserves to the huge reef reservoirs.

Over the central plains area new Cretaceous discoveries will be made as a result of random drilling or drilling for deeper objectives. Substantial Cretaceous discoveries like the Campbell and Joseph Lake fields may be found this way or through subsurface geologic studies. Cretaceous sand oil fields known today probably are indicative of reservoirs that may be found in the future. If this is true, new discoveries will have producible reserves up to 25 million barrels, although most discoveries will not exceed 5 million barrels.

Due to the small size of these oil fields, the discoverer will usually find himself obliged to exploit his find alone using the most careful geologic and engineering techniques. In fact, careful exploratory and development methods combined with luck are necessary for profitable operation of the average Cretaceous oil field of Central Alberta.

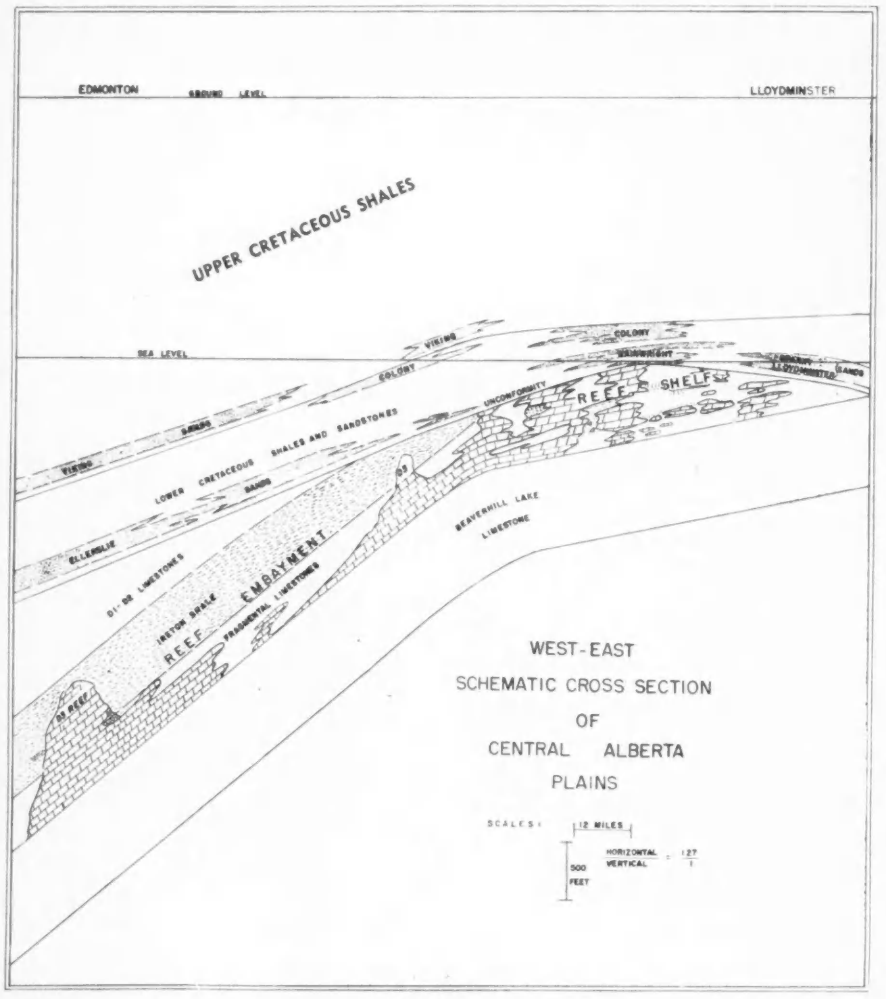
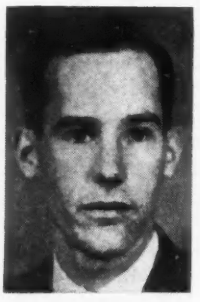


FIGURE 3.



About the Author

C. WARREN HUNT, chief geologist for Pan Western Oils, Western Homestead Oils and Long Island Petroleums, graduated in 1945 from the California Institute of Technology with a bachelor's degree in geology. He was junior geologist for Standard Oil Company of California for a year after graduating, and was field geologist for Independent Exploration Company in Bakersfield, Calif., during 1946-48. In 1948 he became an independent consultant in California, and in 1949 joined the oil boom in Alberta where he worked with Denton-Spencer Company, consulting engineers, and Link and Nauss, exploration consultants. In March, 1951, he started a geological and engineering department for the three associated oil companies for which he now works.

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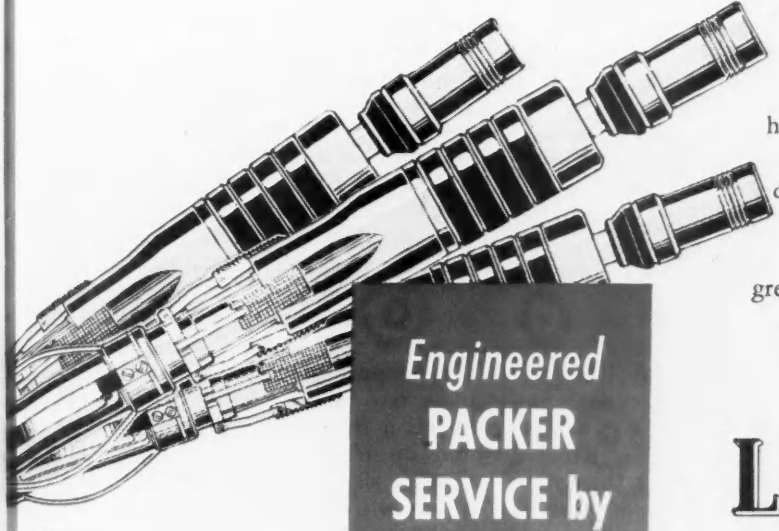

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Drilling unit in Burgan field. Note camel in foreground.

KINGDOMS OF OIL—*No. 10*

KUWAIT

Part 1

By FRANK D. POTTER
Petroleum Engineering Consultant, Tulsa

KUWAIT is a pint-sized country with only one oil field, but any comparison with smallness ends right there. It is a land of big desert area, big water shortage, big crude production. It is a "sheikdom of oil" which pours 650,000 barrels a day into the world market and yet, because of its weather, exacts a heavy toll on man's temper and machinery. But Kuwait's Burgan field is ideal from a technical operating point of view, details of which are included in this "tale of Arabian nights."

HANGING tenaciously to the fierce desert in the land of the Arabian nights is a "sheikdom of oil" in which 20th century technocracy and overtones of the Middle Ages have combined to produce unique contrast and great wealth. In this pint-sized Sheikdom of Kuwait is the Burgan field, whose 110 wells produce 650,000 barrels of oil each day from a proved reserve of at least 11 billion barrels, more than 13 percent of the world's known crude reserves.

In the southeast corner of Kuwait, 15 miles west of the Persian Gulf shore and 30 miles south of Kuwait harbor, Burgan's proximity to the sea lanes has somewhat lightened the herculean task of building this extraordinary oil center.

The Persian Gulf sticks up like a thumb between Persia and the Arabian peninsula, and pointing toward Turkey, it is crowned by the most fabulous oil concessions the world has known. Here, among severe ravages of time and the elements, the discovery and exploitation of vast crude reserves has transformed a pitiful oversight of human progress into a major focal point of world economics. Sharing the tip of the thumb, from right to left, are the concessions of three great oil companies: Anglo-Iranian Oil Company of Iran, the Iraq Petroleum Company of Iraq and the Kuwait Oil Company, which leases the entire Sheikdom of Kuwait. It is the junior member of this group that has stepped out at an astonishing pace over a very few years to create the oil field which is a veritable "Tale of Arabian Nights."

The Persian Gulf area is one of the most uncomfortable places in the world for people from temperate zones. Intense heat of the desert, rising as high as 140 degrees in the shade, combines with humidity of the nearby gulf. It is the desert that strikes the newcomer first and hardest. Wherever you are, the desert is just outside your window, just around the corner, in your shoes, in your eyes and nose.

Most of Kuwait is not, strictly speaking, barren. The skies open once a year or so, and the sand and rocks are speckled with green. Worst is the season of the "Shamal," when northwest gales sweep from across the Iraq border and earn their name from the Arabic word "Arb'ayin" or "the 40 days' wind." Paradoxically, these winds occur during the hottest period of the year, beginning in June and mounting in ferocity until they blow out in September. The desert exacts a heavy toll on man's temper and on machinery; it calls for an average shutdown time of seven days a year while the elements are at their worst.

Between the October rain and

spring is the Kuwait winter, which lasts from about the middle of November to the middle of February. To Europeans, the cold of the Arabian winter acts as a welcome tonic. The desert air has a buoying effect, and a midnight casing job in the oil field can be quite enjoyable.

Toward January a series of frosts occur. At night desert temperature drops to 29 degrees and below, an almost unbelievable change from the summer.

Living quarters at the bachelor camp, Camp Wara. Burgan field is in the background.

Facilities Good

Persian Gulf oil companies must provide considerably more than the usual oil field camp facilities for workers. For its American and British employes, Kuwait Oil Company furnishes air-conditioned living quarters, restaurants, clubs, and many customary facilities of western life. Salary rates are high; consequently, there is little trouble in recruiting technicians. Since the closing days of the drilling campaign, the senior, or white, staff has become predominately British. Americans holding various positions are outnumbered about five to one. For the clerk, foreman and typist staff, the company brought in semiskilled workers from India and Iraq. These people constitute the vast middle class of company population, forming about a third of the total strength. Arabs are gradually being trained to replace imported clerks and semiskilled workmen. This effort alone moves Kuwait ever closer to an equal economic level with her neighbors of the Middle East.

Far more difficult is the securing and training of native laborers who constitute the bulk of the company's personnel. Arabia offers the most violent contrast between the ancient and the modern. Skipping several thousand years of development in one quick jump, her people have been transported from the Middle Ages to the 20th century. Not long ago the only wheels in the country were those on the primitive rigs over hand-dug water wells, where donkeys and camels still go back and forth or round and round hauling up skin bags full of the precious, brackish fluid. Now, Arabs who have never coped with any vehicle more complicated than a camel are driving 30-ton semitrailers with 15 gears. Arabs are traveling in a few hours by airplane over desert that not long ago could be crossed only in weeks by camel. Arabs are manning the modern equipment which takes crude out of their desert and delivers it to the world.

Possibility of finding oil at Kuwait was recognized before the outbreak of World War I, but it was not until December, 1934, that a concession was signed. The previous year had seen the formation of Kuwait Oil Company, as a joint British and American enterprise in which Anglo-Iranian Oil Company, a British concern, and Gulf Oil Corporation became equal partners in the quest for oil rights at Kuwait. It was to this company that Shaikh Sir Ahmad al Jabir al Subah, then ruler of Kuwait, granted the oil concession covering his domain.

Geological surveys conducted in 1935 indicated that two sites were most promising for testing by the drill. The first of these was at Bahrah in the north and the second in the Burgan region. Drilling operations began May 30, 1936. Work on the test well at Bahrah proceeded until April, 1937, when a depth of 7950 feet had been reached without finding oil in commercial quantities. Drilling then was suspended and the camp was moved to Magwa, south of Kuwait town, in preparation for the second test at Burgan.

At Burgan, Kuwait's sole oil field, one of Kuwait's most formidable problems—the shortage of water—began to show itself. Since no potable water could be found in the vicinity, supplies had to be hauled across the desert from Kuwait town, itself dependent upon water imported by sea

The main settlement at Ahmadi. Living quarters are in the foreground, industrial area and tank farm in the background. Burgan field is ten miles in the distance.

from the Shatt al Arab River, which empties into the head of the Persian Gulf near Abadan. Brackish well water was obtainable in limited quantities, but for drilling purposes it was necessary to lay a pipe line to the coast to obtain sea water.

The second test was begun October 16, 1937, and in April, 1938, the first flow of commercial oil at Kuwait had begun. From then until the outbreak of World War II, exploratory work, including an intensive search for water, proceeded. Further drilling substantiated earlier hopes for the existence of an extensive oil field in the Burgan area. Early development days constitute a story of rugged pioneering on the part of British and American field men, harassed constantly by grim environment.

Kuwait concession development was stopped by the war after eight wells had been drilled, but operations were resumed in October, 1945, under a wartime program for the development of Middle East oil resources. Production at the rate of 30,000 barrels a day was scheduled, and the eight completed wells in the Burgan field were placed on production. First commercial shipment of oil from Kuwait occurred June 30, 1946. With removal of some wartime restrictions, it became possible to plan for the large-scale development of the Burgan field.

Results of large-scale planning were soon apparent. By the end of 1947 a dozen wells had been drilled or reconditioned and completed, and production had reached 40,000 barrels a day. By December, 1949, 12 rigs were drilling, 84 wells had been completed, and production had reached 250,000 barrels a day. Mid-1951 found drilling slowed to two rigs and the production from 110 oil wells at 650,000 barrels per day.

About the Author

FRANK D. POTTER is a product of the Bradford, Penn., oil fields. Born in Kane, Penn., he attended public schools in McKean County, Pennsylvania, completing his formal education with a BS degree in petroleum engineering at the University of Pittsburgh. His engineering training with The Texas Company at Salem, Ill., was interrupted by five years of military service during World War II. Service was resumed with The Texas Company at Tulsa, where he became Oklahoma district petroleum engineer. He joined Hinderliter Tool Company of Tulsa as chief engineer in 1947, leaving there for Arabia, where he was employed as engineer assistant to the drilling superintendent for Kuwait Oil Company. Since his return to the U. S., Potter has conducted his own consulting business in Tulsa under the name of Frank Potter and Associates. He is associated with the University of Tulsa as an instructor on the Development of Petroleum Engineering.

Ideal Field

Burgan is an ideal oil field from an operating point of view, but geographic location and climate are factors contributing much toward its obstinacy. All oil must be delivered to the markets of the world by tankers. The Persian Gulf fields are within 1000 miles of the eastern Mediterranean shores, but the tanker trip from the gulf by way of the Suez Canal is about 3600 miles. Although geographically nearer the European markets than competing producers of the Gulf of Mexico area, Kuwait production is hampered by the circuitous sea route around the Arabian peninsula and the Suez Canal toll of 18 cents a barrel.

Problem of supply to the oil field is a continuing one. Every pound of equipment and practically all building materials have come from the manufacturing centers far removed from the Middle East. There is no material available locally except sand, rock and a small extrusion of bitumen. Bulk of oil field equipment is of American manufacture, which was supplied to the field during the four-year period following the war; however, as a result of the devaluation of pound sterling, British equipment is now substituted wherever possible. Practically all building materials have come from the United Kingdom. Regardless of the source of materials, vast supplies of company-owned goods must be anticipated and stocked to meet demands of eight major departments. The facility of driving to town to get "it" from the supply store does not exist. If goods are not in company stock and are needed, they have to be made with the most likely piece of junk at hand. This is best illustrated by a priority job handed the drilling department: a series of exploratory wells intended to find fresh water for the sheik. A camp was established near the Iraq border, complete with mess section and medics. After much preparation and delay, the project got well into its third hole before the crew buckled the center section of their collapsible mast beyond repair. With no replacement part available in the Middle East, those unsung heroes of the machine shops, armed with a few dimensions, set to work. From raw stock metal they created the replacement, complete with safety factor, which required just a little silver paint to make it look newly arrived from the U. S.

(First of Two Parts)

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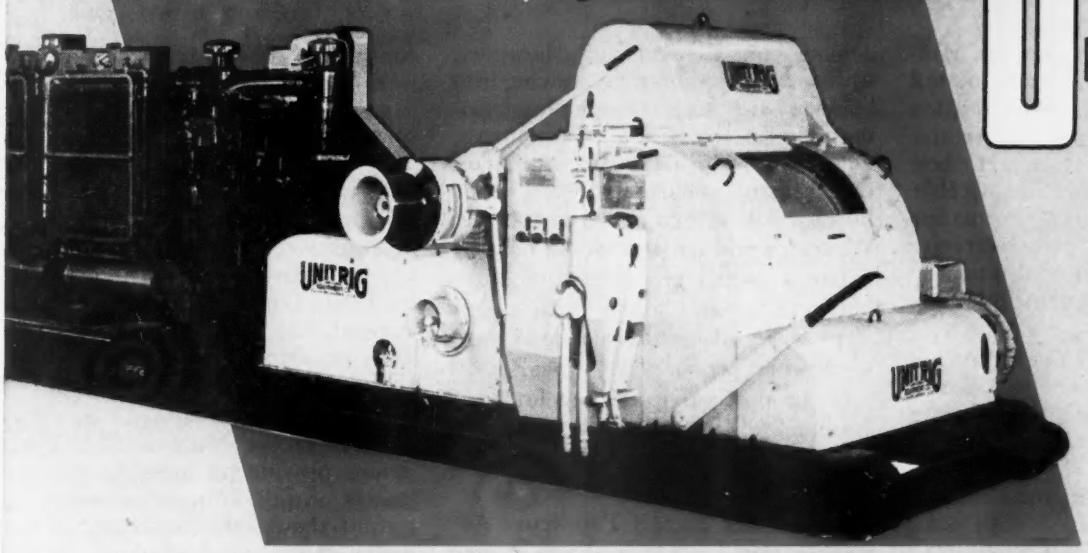

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Folly vs. Fundamentals

Iran Still Awaits Oil Grab Benefits

SHORTLY after Premier Mossadegh's followers forced through the oil nationalization law, Iranians lined up at service stations with empty cans to get their free share of the nation's new wealth. Months later, a near-bankrupt nation still waits with empty cans to receive the first benefits from its action of expulsion of Anglo-Iranian Oil Company.

Iran's National Oil Company has been able to keep the 2400-barrel daily Kermanshah skimming plant going to supply local demand—never more than 2000 barrels a day—and has gotten the giant Abadan refinery partially back on stream with some of the more than 70,000 nationals formerly employed by the British. The government, however, desperately needs large volume purchasers for its petroleum, but so far no tankers have arrived to move Iranian oil. Iran's frantic efforts to get bailed out of its oil muddle may create a more serious problem than when Anglo-Iranian was legislated out and the nation's oil was closed to world markets.

While Mossadegh substituted folly for fundamentals in his negotiations with the British after the March 15 nationalization law, oil producers were rapidly building up production for world needs principally from other Middle East nations and with some assistance from Venezuela and the U. S. Total output from the areas fringing the Persian Gulf now has increased to offset the Iranian loss, and the effective redistribution of world production by the U. S.-formed Foreign Petroleum Supply Committee has eliminated world dependence on Iran's oil, which formerly accounted for 6 percent of the total global output.

Politically, the Western nations and, for protection of its substantial investment, Anglo-Iranian would prefer to conclude a workable arrangement with Iran to get its oil industry operating again for the benefit of the democracies. Economically, however, with world supply rapidly moving into balance with total demand and potentially in excess of requirements, new barriers to a speedy solution of the Iranian problem will have to be hurdled. A return of Iran's oil to Western world markets would initially create a global glut of petroleum—barring an early allout war—unless steps were taken to scale downward worldwide production in nearly direct proportion to the volume of Iranian exports.

U. S. producers already are aware of the need for such a trend. As recently as last August Petroleum Administration for Defense was urging domestic output be boosted to maximum efficiency rates to help offset a feared shortage of oil. None occurred except temporarily in widely scattered small-consuming areas, and state conservation agencies since have ordered cutbacks from peak producing levels as the need for U. S. oil exports diminished to prevent physical—and possibly economic—waste of petroleum.

A different situation exists outside the U. S. Most governments are more concerned with their finances than in conserving natural resources. While Mossadegh argued and fainted on two continents, other Middle East rulers were quietly pressing demands for higher basic royalties. Since last spring, Iraq and, more recently, Kuwait have reached new agreements with their concessionaires, both basically patterned after the 50-50 split of profits set by Arabian American Oil Company and Saudi Arabia late in 1950. For the tiny sheikdom of Kuwait, the higher ante hikes total daily royalties to about $225,000 from slightly under $70,000 at current producing rates.

Such larger bites into company profits provide no incentive for producers outside Iran to reduce future output should the latter nation's oil again enter world markets through the Anglo-Iranian organization, which is a partner in both Iraq and Kuwait. Also, higher royalties and mounting production ring a merry tune as the coins flow into the counting houses of Saudi Arabia, Iraq and Kuwait. Any reduction in total payments incident to lower producing levels might be viewed with royal displeasure.

Higher production rates of other areas have endangered Mossadegh's bargaining position to the extent that he has made a turnabout and proposed a sales offer with Anglo-Iranian. This may be indicative of some change in Iran's economic and political thinking. Nationalization cut off more than a third of the nation's budgetary income, and while agriculture, local commerce and the carpet industry will continue providing for a large number of Iran's 17-odd million poverty-stricken people, the government's financial status is rapidly deteriorating to the point where it is dependent on emergency measures to meet its obligations. During his more than a month in the U. S., Mossadegh was only able to arrange from the International Monetary Fund a relatively small dollar credit of $8,750,000, the equivalent to a little more than a month's take from Anglo-Iranian during 1950. The credit

Trend of Middle East Oil Production
(Daily Average in Barrels)

PERIOD	Iran	Iraq	Kuwait	Saudi Arabia
1945	349,060	88,628	.....	89,386
1946	396,975	89,800	16,411	165,318
1947	424,277	91,720	44,458	246,170
1948	520,175	72,311	127,178	390,309
1949	560,855	86,929	246,383	467,737
1950	661,438	128,110	344,444	546,704
1951:				
January	643,548	168,600	435,700	561,201
February	700,285	169,403	338,779	633,718
March	695,200	169,200	375,383	638,983
April	561,640	171,150	502,493	695,121
May	731,793	172,700	507,800	739,780
June	638,520	173,000	542,749	758,705
July	115,900	173,000	649,409	820,110
August	9,316*	173,000	690,362	837,797
September	.....	173,000	628,683	847,067
October	.....	173,000	708,240	848,076

* Export shipments were ended in July.

amounts to no more than a guarantee to give Iran dollars in exchange for Iranian rials equal to Iran's gold deposits with the fund. An additional $25 million in indirect relief will be available to Iran through the Mutual Security Aid Relief, but it will not be available to the government to pay salaries of civil servants.

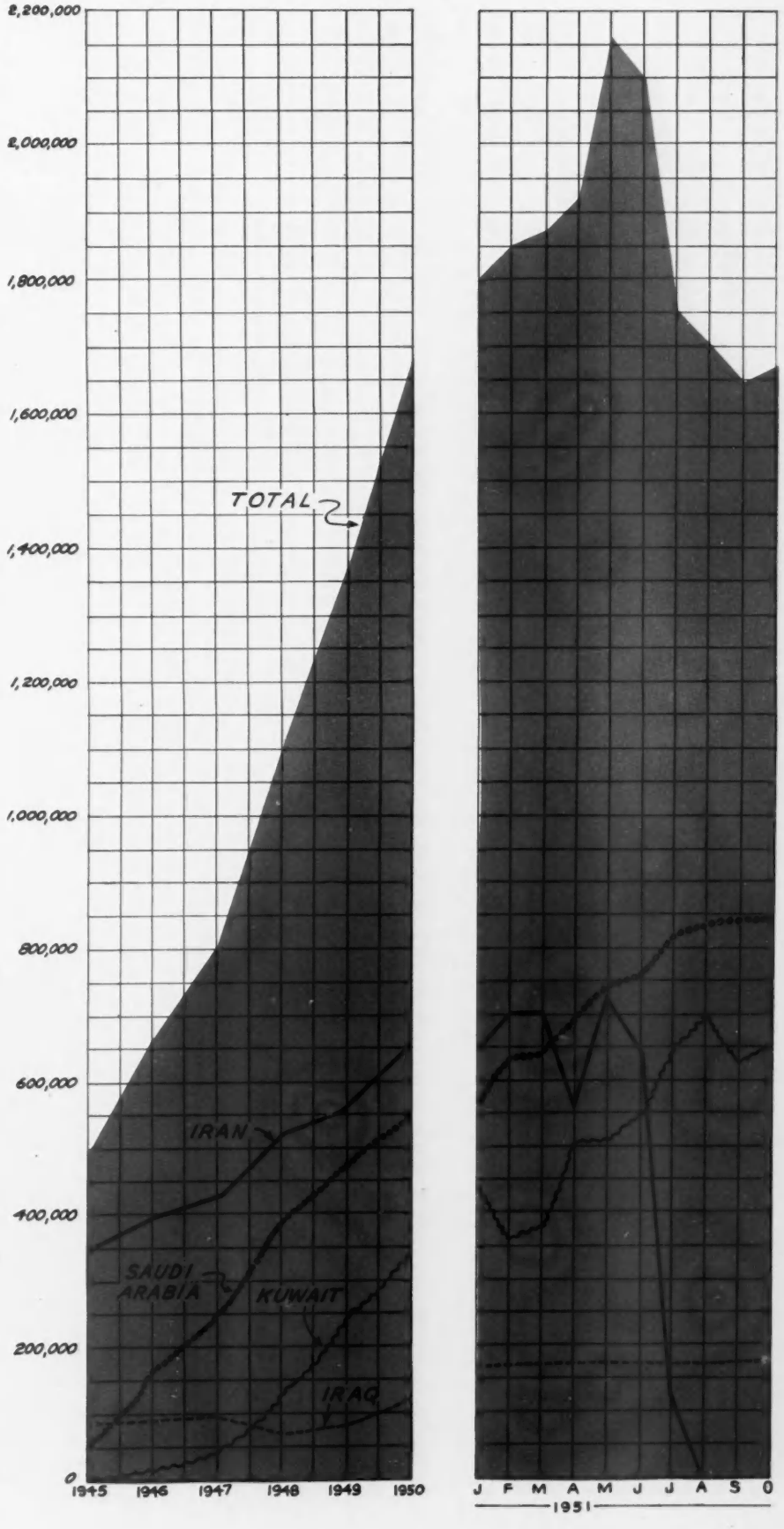
Though Mossadegh has continued to lead the world to believe he may eventually bargain with the Soviet Union or other communist nations in the event the western world does not help solve Iran's problems, it was learned during the Iranian delegation's visit to the U. S. that the Iranians are fully mindful of the dubious economic and political results of any possible deal with the Russians. Like U. S. experts, the more level-headed Iranians do not believe Russia has the steel or know-how to build a pipe line to move Iranian oil northward over the mountains to the Soviet Union. And other means of transportation are inadequate. Petroleum shipments over the single-track rail link to the USSR during wartime lend-lease never reached 7000 barrels daily at their peak, even when U. S. engineers directed railway operations. According to best estimates, Russia and its satellites combined have an ocean-going tanker fleet of less than 25 vessels, or 1/12 of the fleet of 300 owned and chartered ships operated by Anglo-Iranian.

Under more harmonious working agreements, current output for Kuwait's single Burgan field, which had its first commercial production in 1946, has increased to nearly 700,000 barrels daily, more than twice the 1950 rate and more than 60 percent higher than last January's production. Saudi Arabia, which next to Kuwait has had the sharpest increase, topped Iran's record production level last May and continued increases since have boosted the total to about 850,000 barrels daily. This rate is 55 percent higher than the first of the year and makes Aramco the world's largest crude producer.

Iraq's current production is limited to no more than 180,000 barrels a day, the capacity of the single operating 12- and 16-inch pipe line from the Kirkuk field to Tripoli, Lebanon. A similar size line to the Mediterranean, terminating at Haifa, Israel, is closed because of political complications. Completion in 1952 of the 560-mile line to Banias, Syria, and a shorter line between Zubair and Fao on the Persian Gulf is expected to

CONTINUED ON PAGE 248

TRENDS IN MIDDLE EAST CRUDE PRODUCTION 1945-51



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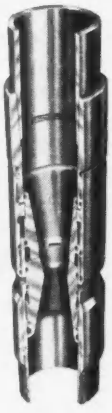

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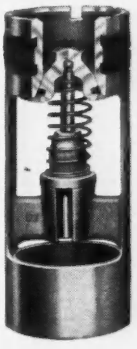

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EGYPT—
The Next Iran?

By ROBERT E. SPANN
WORLD OIL Staff

WHAT WILL Egypt do with its oil? Will it continue cloaking current prospective areas with laws which, in effect, prevent foreign companies spending huge sums in exploration and exploitation, if oil is found? Or will the government clear the way for fuller petroleum development by companies and individuals capable of underwriting the risk? This summary of events in Egypt discusses current progress in Egypt to open the area to foreign operations.

NEW promises of the Egyptian government for early consideration of amendments to its Mines and Quarries Law of 1948 could possibly create another crisis in international petroleum operations. While the nation's oil production is small and for the most part locally consumed, it has had a significant rise to an average of more than 44,000 barrels daily in 1951, an increase of 93 percent in the last decade.

Against the background of the present political emergency in the kingdom on the Nile over continued British military occupancy of the Suez Canal Zone and the general nationalistic agitation against foreign "domination," the present British and American oil concessionaires do not now welcome an open debate in parliament on revised petroleum legislation.

The originally drafted amendments to the petroleum law as first proposed in 1950, but never brought to a vote, would have established minimum acceptable terms to the operating companies but would not have removed all of the objectionable features of the 1948 law. Under the present internal conditions, however, the two operating companies—Anglo-Egyptian Oilfields, Ltd. (Shell) and Socony-Vacuum Oil Company, Inc.—are skeptical over any petroleum legislation that could be enacted.

Egypt's revived interest in its petroleum legislation stems from a desire to get additional firms to participate in petroleum development. During the 3½ years since the present law was passed, Egyptian oil operations have moved slowly. Activity has consisted mostly of limited development of producing leases acquired prior to June, 1948, since only Egyptian companies —those whose capital is owned 51 percent by Egyptian nationals—can be granted new leases under the 1948 law. This and other restrictive provisions of the act caused Standard Oil Company of Egypt (Jersey Standard) to abandon operations in the country in 1949 after 12 years of exploratory work and one oil discovery on the Sinai Peninsula. This discovery was made shortly before the company decided to leave Egypt and has never been placed on production. Both Anglo-Egyptian and Socony-Vacuum previously have stated their intentions of leaving Egypt unless fundamental changes in the law are made.

Attempts by the Egyptian government to stir up additional interest in developing its petroleum resources have failed. Early in 1950 National Petroleum Company of Egypt was formed by private Egyptian capital with government encouragement and acquired some of the former Standard of Egypt's exploration licenses on both sides of the Gulf of Suez and in Western Egypt. Other former Standard of Egypt tracts were passed out to another group of Egyptians, but neither of these entities made any serious effort to conduct exploratory campaigns.

May Modify Law

Recently, the government has indicated it is willing to consider modification of its 1948 law as an inducement to new enterprises. This action is based largely on the interest in Egyptian oil development of a new group composed of Glenn McCarthy, a Texas independent producer; Dr. Stanislaus de Lazovert, a French oil operator, and a Swiss banking firm, the Hofman Bank Aitien Gellshaft of Zurich. This group has signed an agreement in principle to buy 51 percent of the stock of National Petroleum of Egypt dependent upon changes in the 1948 petroleum law, primarily the Egyptian company requirement for production leases. National Petroleum presently holds ex-

TABLE 1

Statistical Summary of the Egyptian Petroleum Industry

(Data Complete as of June 30, 1951)

Name of Field	Ras Gharib*	Hurghada*	Gemsa* (Abnd.)	Ras Matarma*	Sudr†	Asl†
Year of Discovery	1938	1913	1908	1948	1946	1948
Footage Drilled 1951	7456	....	....	....	14,145	9744
Wells Completed 1951: Oil	3	....	....	....	4	....
Gas	....	....	....	....	....	....
Dry	....	....	....	....	1	2
Wells Drilling, 6-30-51	1	....	....	....	1	1
Wells Suspended, 6-30-51	....	....	....	....	1	....
No. of Flowing Wells	14	....	....	....	8	7
No. of Pumping Wells	70	23	....	....	1	....
No. Wells on Gas Lift	17	....	....	....	....	....
No. Wells Shut In	26	5	1	3	6	....
Producing Depth	1200-2500	700-2500	400-2000	1940-3200	2000-3100	2870-3870
Total Crude Production 1951 (Barrels)	3,923,577	171,039	....	....	1,623,637	2,322,815
Daily Average in June (Bbls.)	22,521	908	....	....	11,580	12,536
Accumulated Production at 6-30-51 (Barrels)	98,699,988	37,615,721	1,442,098	....	14,938,093	7,838,297
A.P.I. Gravity of Crude	25-26	22-30	41	20	19-23	22
Producing Formation	Carboniferous & Cretaceous Sands and Miocene Limestone	Carboniferous & Cretaceous Sands and Miocene Conglomerate	Miocene Limestone	Mid-Miocene Limestone and Eocene Limestone	Mid-Miocene Limestone and Eocene Limestone	Eocene Limestone
Type of Structure	Faulted Monocline	Anticline	Anticline	Anticline	Anticline	Anticline

* Operating Company is Anglo-Egyptian Oilfields, Ltd. (Royal Dutch-Shell).
† Operating Company is Anglo-Egyptian and Socony-Vacuum Oil Company.

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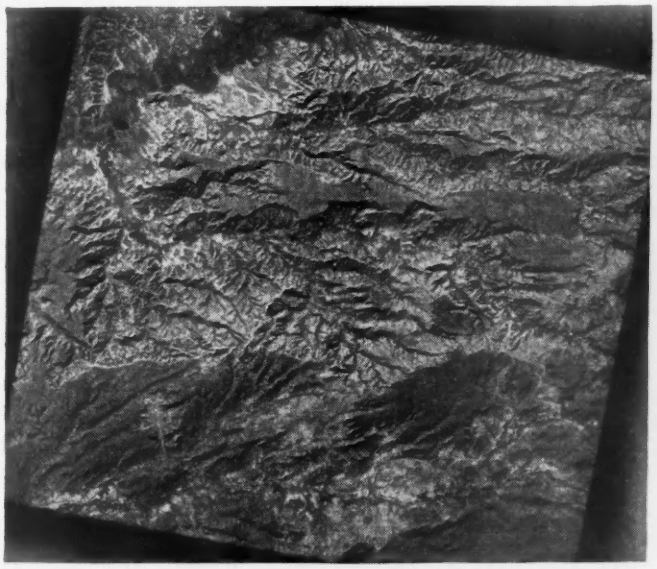
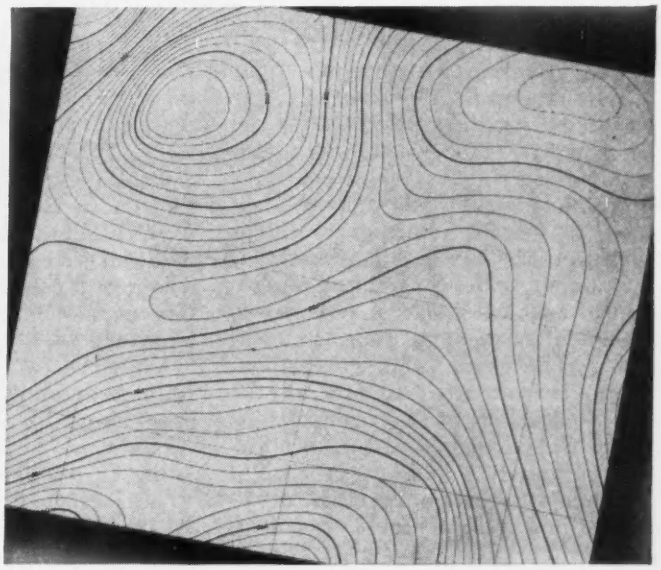


Air photos are useful in geologic study and exploration planning.



These anomalies are typical of the magnetic figure in petroleum exploration.

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While the amendments proposed in 1950 would have eliminated the Egyptian company requirements, operating companies in Egypt would have been required to keep their accounts in the country and priority would be given Egyptian companies in the event of simultaneous application or bidding for exploration licenses. Also, the originally proposed changes would have reduced drilling obligations to the extent that on exploration licenses a maximum of two rigs would be required to be kept in operation after the fourth year of a permit in order to get extensions. The present requirement is that drilling must start in the fourth year of an exploration license and be continuous as a prerequisite to getting further extensions.

The Egyptian government's right to purchase up to 20 percent of crude or refined products produced in the country at prices 20 percent under world market quotations would have been limited under the proposed law revision. On his return from Egypt recently, McCarthy was quoted as saying that, under the agreement with the government and the prospective owners of controlling interest in National Petroleum, the government would be permitted to buy all the oil it needed from the company at world market prices, should production be found.

While production royalties of 15 percent on half a license area converted to a production lease and 25 percent on the remaining portion would have been left unchanged in the 1950 proposals, the present view is that under any revisions in its petroleum law Egypt would demand higher royalties in view of the 1951 agreements made in the Middle East for an equal sharing of profits between operating companies and governments.

TABLE 2

Ten-Year Production of the Egyptian Petroleum Industry

(Daily Average Barrels)

YEAR	Production
1941	23,414
1942	22,671
1943	24,538
1944	25,798
1945	25,771
1946	24,849
1947	23,686
1948	35,992
1949	43,457
1950	44,589
1951	44,369*

*Average for ten months.

During the delay in getting a revised law, development of the nation's petroleum resources, rated "good" by prominent geologists, has been held in abeyance. Interest in exploratory drilling has subsided greatly since the post-war peak drilling campaign of 1948, when a total of 20 wells were completed of which six were wildcats. Two of the latter brought in new fields, Asl and Ras Matarma, both on the Sinai Peninsula. Asl discovery, a joint operation of Anglo-Egyptian and Socony, was made in early 1948 just prior to the passage of the present law. The field currently produces at a rate of 12,500 barrels daily from seven flowing wells.

Ras Matarma, however, came in after the law was enacted and, because of the unsatisfactory lease terms, has never been placed on commercial production. In fact, only three wells have been completed. No exploratory wells were drilled in 1951, and, during the first half of the year, ten completions were made by the two operating companies in proven areas, resulting in seven oil wells and three dry holes. Three oil wells were completed by Anglo-Egyptian on its Ras Gharib lease on the western shore of the Gulf of Suez, and four successful wells were finaled by the two companies in their operation of the Sudr field on the Sinai Peninsula.

With the two discoveries in 1948, the first and only since the Sudr field was found in 1946, Egyptian oil production had its biggest increase, rising 12,300 barrels daily over 1947 to an average of 35,992 barrels a day. A further increase of nearly 7500 barrels daily was made in 1949, but since then daily average output with only a few exceptions has been just a little more than 44,000 barrels a day. Actually production is limited to the capacity of the two refineries at Suez, a 40,000-barrel daily plant of Anglo-Egyptian and a 6000-barrel plant operated by the government, since the law prohibits exports except in the form of refined products processed in Egypt. Present domestic requirements amount to nearly all of the present refining capacity.

Results of Egypt's short-sighted policy for development of petroleum resources were indicated last month when a reported agreement was reached between the Ministry of Mines and Iranian oil officials whereby Egypt would import Iranian oil if and when Iran finds a way to commence export shipments of its nationalized petroleum now displacing all available storage capacity in the country.

Iran Awaits Oil Benefits

CONTINUED FROM PAGE 243

boost total Iraqi production to about 600,000 barrels daily by the start of 1953. Iraq Petroleum Company's royalty agreement requires minimum production of 450,000 barrels daily in 1954 and 610,000 barrels a day by 1955. Under these conditions, once IPC reaches its expected production rate cutbacks will be impossible should a possible return of Iranian oil result in a substantial excess of supply.

Though a smaller producer, Qatar has had a fast rise in output with the current average of Petroleum Development Company (like IPC this is owned by Anglo-Iranian, Compaigne Francaise de Petroles, Royal Dutch-Shell and Near East Development Corporation, each with a 23.75 percent interest, and C. S. Gulbenkian, an individual, with the remaining 5 percent). The first year of commercial production amounted to 23 times the 2045 barrels daily in 1949.

While events such as the Iranian nationalization and political uncertainties elsewhere in the world have had the effect of holding up exploratory development of new areas, producers still are looking for sources of oil nearer to large marketing areas. At least indirectly associated with Iran's shutdown of the Abadan refinery was the commencement by Standard-Vacuum Oil Company of aerial magnetometer reconnaissance of a 73,000-square mile section of the alluvial plain at the head of the Bay of Bengal in Eastern India and East Pakistan. Both nations in the postwar years have encouraged the search by private capital in moves to eliminate dependence on imported petroleum, heretofore supplied by Iran.

Stanvac expects to complete its surveys early in 1952 and, if results are encouraging, presumably would apply for prospecting licenses. Burmah Oil Company, through its subsidiaries, presently has all the production in the two nations, amounting to about 5000 barrels in India's Digboi field of Assam province in the extreme east and approximately 3000 barrels daily from West Pakistan's four Punjab fields.

An additional development that may be tied to Iran's failure at operating its oil industry under nationalization is the recent move by the government of the Union of Burma to modify the demands of the extreme nationalists for outright confiscation of Burmah Oil's properties there.

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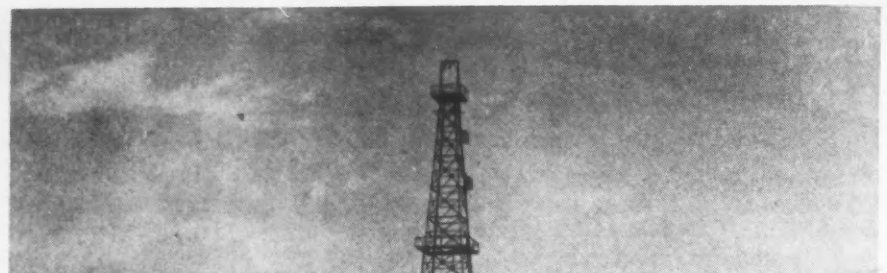
PAKISTAN TEST DRILLING



TOP. Pakistan Petroleum's test well at Sui.

CENTER. Derrick view of warehouse area in foreground, and camp in the background.

BOTTOM. Office, garage and workshop in foreground, with staff quarters, canteen and hospital in background.

PAKISTAN Petroleum Limited's first test at Sui, Dera Bugti (Baluchistan) is being drilled by a diesel engined rig capable of reaching a depth of 10,000 feet. Site for this initial exploration resulted from geological work and aerial reconnaissance of about 5000 square miles of Mari-Bugti territory which led to the discovery of the Sui anticline.

Prospecting area is situated at the southern end of the Sulaiman range, and consists chiefly of narrow parallel ridges of closely-packed hills, which form a gradual descent from the Sulaiman plateau into the plains. Intersected by ravines, it is generally barren, rugged and sandy, poorly supplied with water, and inhospitable. The climate, ranging up to 125° F in the summer shade, drops to below freezing in winter.

Preliminary work was started early this year when the Pakistan government granted an oil prospecting license to Pakistan Petroleum. To expedite work, the company opened a railhead base at Kashmor on the narrow-gauge railway from Jacobabad to receive about 6500 tons of stores required for the project.

Well site was a desolate spot with not even a foot path leading to it. A 35-mile road winding through plains, along hill slopes, across the dry, sandy bed of the Heran Nala and through sand dunes was built to link the site with Kashmor railhead. A 40-mile, four-inch pipe line was laid with a pump station at the Indus river and a booster station to pump water to the desert camp.

Camp houses are Nissen huts of special design to alleviate the summer heat and winter cold. A power station supplies electricity for the well and light for the camp of about 150 persons, in addition to a hospital with an air-conditioned ward for heat stroke patients.

An air strip was constructed near the site, and communication is maintained by radio with Karachi headquarters. A direct telephone line links well and railhead. An up-to-date canteen and food shop provides goods at cost.

Edmonton-Vancouver Line Approved

Canada's Transport Board has approved the application of Trans-Mountain Oil Pipeline Company to build an $82 million, 693-mile link from Edmonton, Alberta, through the Yellowhead Pass to Vancouver, British Columbia, on the West Coast. Construction is expected to begin next spring.

Premier Byron Johnson reported earlier that the British Columbia government would speak in behalf of Trans-Mountain when the company's application for an oil export permit was heard by the Federal Board of Transport commissioners, which began December 10.

Trans-Mountain supporters include Imperial Oil Ltd.; Standard Oil Company of British Columbia, Ltd.; Shell Oil Company of Canada, Ltd.; Canadian Gulf Oil Company, Ltd.; Union Oil Company of California; Richfield Oil Company, and S. C. Bechtel and associates, the latter a U. S. engineering firm.

Aerial reconnaissance surveys have been made of the route, according to Trans-Mountain officials, and survey parties are working along the route of the crude outlet, preparing detailed reports. S. M. Blair, vice president of the pipe line firm, said the line could be in operation by the end of 1953.

According to reports from Victoria, the line will have an initial capacity of 75,000 barrels of crude daily, with an ultimate capacity of 200,000 barrels a day. From "the vicinity of Edmonton," the line will be laid almost due west to Jasper National Park, then over the Continental Divide through the Yellowhead Pass, southward down the North Thompson River to Kamloops, B. C., thence southwest to Merritt, along the Kettle Valley, up the Coldwater River, down through the Coquihalla Canyon to Hope, along the south side of the Fraser River across the Lower Fraser Valley to Port Mann, and then to the proposed terminal at Burnaby, a Vancouver suburb, where storage facilities will be located.

Spokesmen for the British Columbia government had said if the line is built it will be a major economic factor in the development of the central region of interior British Columbia.

Saskatchewan Deep Test Abandoned After Failure

Shell-Big Muddy 1, deepest well ever drilled in Saskatchewan province, has been abandoned.

Big Muddy was drilled in the Williston Basin area of southern Saskatchewan to a completion depth of almost two miles. Drilling operations continued five months and cost about $600,000.

Officials of Shell Oil Company said the venture had not been a total loss. Valuable information was added to Saskatchewan's oil exploration records.

The Williston Basin extends throughout southern Saskatchewan and Manitoba into Montana and the Dakotas. Valuable oil strikes have been made on the U. S. side and a few small producers have been completed in Manitoba.

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Pakistan Petroleum, Inc, Prospecting on Wide Scale

Drilling of rotary core holes northeast of the town of Sylhet, in Pakistan, is underway by Pakistan Petroleum Limited, which is carrying out extensive oil prospecting activities in East and West Pakistan for the first time in Pakistan history. The core holes will be drilled to 4000 feet each.

In Sylhet, the older and possibly oil-bearing beds are deeply buried beneath much younger and more recent rocks and interpretation of the structure is difficult.

After drilling these core holes, an electrical log of each hole will be made to measure the electrical properties of the rocks penetrated.

Ground reconnaissance, shipment of stores, and construction of a camp for this project was taken up early this year when Pakistan Petroleum Limited received an exploration license from the government over an area of 4950 square miles in Sylhet and Tippera.

According to Pakistan Petroleum, six months will be required to complete the work and obtain necessary information to plan future program of drilling a deep test.

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Soviets Extract Record Yield From Zistersdorf

Sources in Zistersdorf, Austria, say Soviet Russia extracted 15,283,520 barrels of oil from Austrian fields in 1950, exceeding the highest estimates made by the Soviet Mineral Oil Administration.

This production exceeds all former yearly totals. The highest figure heretofore was reached in 1944 when, under German management, the fields supplied Nazi war machinery with 9,961,580 barrels. Before World War II, production was kept at a steady 477,600 barrels per year, the then known deposits being estimated as good for a 40-year supply before depletion.

New drilling machinery has resulted in ten more wells for the Bockfliess area. Additional equipment was shipped to the Soviet-monopolized oil fields from Eastern Germany and was obtained, in part, from Roumania's Ploesti oil fields, which were formerly operated by U. S. and British interests. The Roumanian equipment is American in origin and built during 1936-1938.

Austria's current monthly average is approximately 1,200,000 barrels, out of which 27 percent is allotted Austria at prices which run 720 percent more than the prewar price level.

Latest estimates, based on the 15-million-barrel production figure for 1950, indicate that Zistersdorf oil fields will be depleted within the next eight years.

22 Wells Completed

Though total German footage drilled during August totaled 115,246, approximately 12,136 feet short of the previous month, the German drilling industry successfully completed 22 wells during the month, including extension wells Hohne 6, Lingen 56 and Ruehlermoor 30. The wildcat Wolfskehlen 1, which blew out at the beginning of August, indicated a natural gas deposit which might be commercially exploited.

Trade Pact Is Studied

Representatives of the Federal Republic of Germany and Mexico are negotiating a two-year trade agreement under which Germany will export finished industrial products to Mexico in return for approximately 4 million barrels of fuel oil annually. Mexico will supply topping residues from Poza Rica crude. Settlement will be made on the basis of prevailing world market crude prices.

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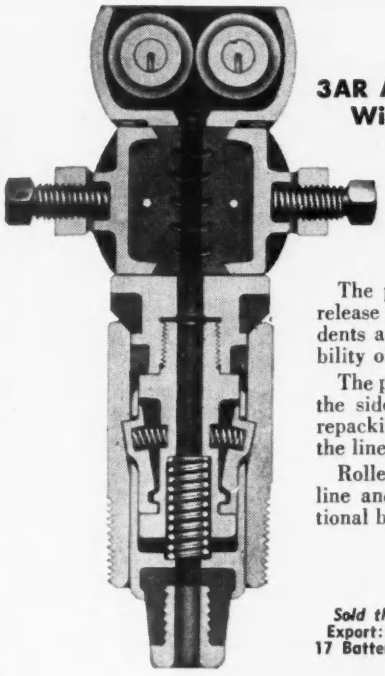

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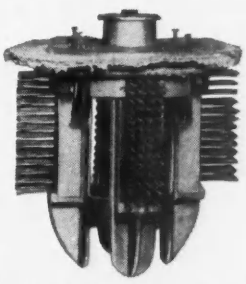

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Joseph Lake Connected To Interprovincial Line

A 24-mile oil pipe line connecting Alberta's Joseph Lake field with the Interprovincial Pipe Line terminal at Edmonton went into operation in December. Another line, from the newly-discovered Wizard Lake sector to Edmonton, was scheduled for completion by mid-December.

Built by the Edmonton Pipe Line Company, the Joseph Lake line includes 20 miles of six-inch pipe between the field and the Interprovincial terminal, plus a three-inch network of gathering and feeder line within the field itself.

Participating in the $500,000 oil outlet are five independent Calgary oil firms, each with a 10 percent interest, and a private corporation which holds the remaining 50 percent. The five oil companies, known as the "Joseph Lake development team," are Superior Oils of Canada Limited, General Petroleums of Canada Limited, Kroy Oils Limited, Jupiter Oils Limited, and Conick Petroleums Limited.

The five-company team owns 62 of 67 producing oil wells at Joseph Lake.

Nearing completion, the Wizard Lake pipe line was to join that promising new sector with the Interprovincial terminal and McColl Frontenac Oil Company's Edmonton refinery. This line runs 42 miles, via Nisku.

The Joseph Lake pipe line will have an initial capacity of between 2500 and 3000 barrels of crude daily. The Wizard Lake line will transmit 12,000 barrels daily on gravity feed, and will be designed so that installation of pumping equipment could boost the capacity of 30,000 barrels daily.

YPF Reports Discovery

Yacimientos Petroliferos Fiscales technicians reported discovery of a new Argentina petroleum deposit at Campo Duran, in the Department of San Martin, Santa Province. In preliminary tests, the well produced approximately 1100 barrels of crude from 11,853 feet, establishing a deep producer record, according to the Argentine Ministry of Industry and Commerce, Buenos Aires.

Algiers Refinery To Go Up

An Austrian construction company has received an order to erect a refinery of approximately 2 million barrels annual capacity near Algiers in the French North African province.

Iran Is Operating One Abadan Distillation Unit

To meet current domestic demand, National Iranian Oil Company is operating one of the distillation units at the Abadan refinery, with a daily throughput of approximately 80,000 barrels from the Agha Jari oil field. Daily production comprises 24 percent gasoline and liquefied gas and 10 percent kerosine. Distillation residues are used primarily for heating purposes.

All plants in the oil town at the Schatt-el-Arab river, which now has a population of more than 200,000, are still in the same condition as they were when the last British engineers and officials departed several weeks ago.

Exploration Reveals Oil In Upper Austria Zone

In the U. S.-occupied zone of Upper Austria, province of Ober-Oesterreich, the privately-owned ROH Oel Gewinnungs-Gesellschaft (Crude Oil Extraction Company) reported that exploration indicates approximately the same amount of oil is available in Upper Austria deposits as in the Soviet-occupied Zistersdorf oil fields in Lower Austria.

Largest deposits are said to be in the triangular area of Ried, Bad Hall and Gmunden, bordered by the Salzach and Mattig Rivers. Since 1906, when the first Austrian crude was found in Taufkirchen, 360 feet below the surface, a search for oil in this district has continued intermittently.

New German Exploratory Test Reaches 2950 Feet

Gewerkschaft Elwerath's Wolfskehlen 2, drilled to explore the Wolfskehlen structure, has reached approximately 2950 feet. Traces of gas in heavy drilling mud indicate gas horizons in the Hydrobien layers of Lower Miocene found in the blowout well, Wolfskehlen 1.

Work on Wolfskehlen 1 has been temporarily suspended. After tubes were installed and the well cemented with 5000 sacks of cement, water was pumped in and the wellhead kept under control. Gas which had gathered in the well was burned off with torches.

Wolfskehlen 3, being drilled farther west on the flanks of the Wolfskehlen structure, has reached 2099 feet.

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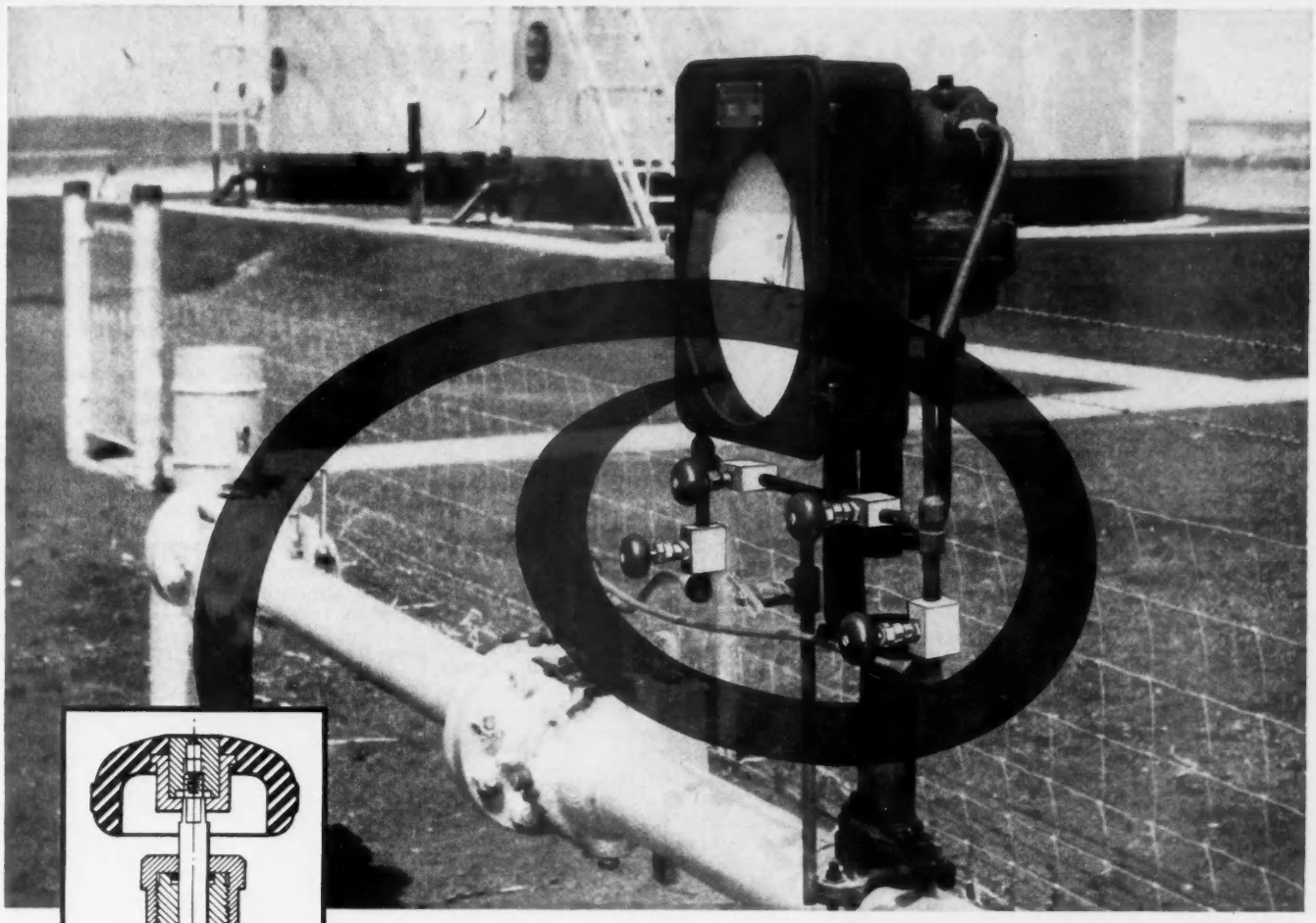

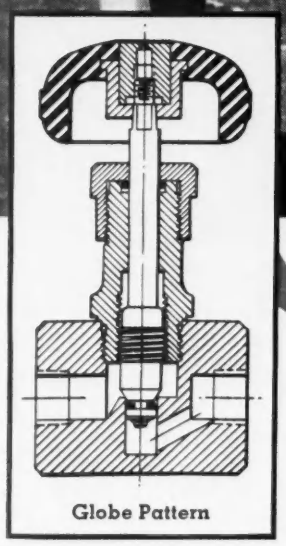

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Men in the Industry NEWS

R. B. McLaughlin, president of The Texas Pipe Line Company, has been elected to the newly-created position of chairman of the board. **J. W. Emison,** vice president and general manager, succeeds McLaughlin as president, and **J. T. Rynd,** vice president and assistant general manager, has been made vice president and general manager.

F. A. Stivers, a director of the company as well as vice president and assistant general manager, has resigned and has been replaced by **L. F. Scherer,** assistant general manager (construction and engineering.)

McLaughlin started wrok for The Texas Company in 1906. When The Texas Pipe Line Company was organized in 1917 he became its assistant secretary. He was elected president and general manager in 1947.

Emison started as a clerk with the company in 1920. He was elected vice president and assistant general manager in 1947.

Rynd started work in the oil industry in 1908, and joined The Texas Company in 1913. He has served continuously since then in pipe line operations.

Stivers, who is retiring as an officer and a director, joined The Texas Company in 1917, and since 1928 has participated in the construction and operations of Texaco pipe lines.

•

Maston Nixon, Corpus Christi oil man, was named president of Southern Minerals Corporation and Southern Pipe Line Corporation. He succeeds **Clarence M. Brown,** former president, who was made chairman of the board.

Maston Nixon

Both Southern Minerals and Southern Pipe Line have headquarters at Corpus Christi and are jointly owned by Pittsburgh Plate Glass Company and American Cyanamid Company. Brown, board chairman of Pittsburgh Plate Glass and its subsidiary, Columbia-Southern Chemical Corporation, and Nixon, in charge of the oil and gas operations since formation of the corporation more than 20 years ago, have directed the growth of these companies.

Nixon is a director of the American Petroleum Institute, Independent Petroleum Association of America and Texas Independent Producers and Royalty Owners Association, and is past president of Texas Mid-Continent Oil and Gas Association.

•

Norman D. Fitzgerald of Abilene, Texas, in partnership with **D. D. St. John,** has bought a second rotary rig for drilling in West Central Texas under the firm name of Saxon Drilling Company. The company is operating in Jones and Runnels counties, drilling wells from 3500 to 4500 feet deep.

G. J. Smith

E. V. Hewitt

G. J. Smith, superintendent of the Exploration department, and **E. V. Hewitt,** general superintendent, have been elected vice presidents of Pan American Production Company. **A. W. Lott,** administrative assistant, has been elected assistant secretary of the production company and the Pan American Gas Company.

Smith joined The California Company after being graduated from the University of Minnesota in 1925. He joined Pan American in 1936 as a geologist.

Hewitt entered the oil industry in 1921, after attending the University of Michigan, as a district superintendent for Michigan Petroleum Corporation. In 1935 he became a field foreman for Pan American, and in 1938 was named general superintendent in charge of drilling and production operations.

•

Emile E. Soubry has been elected a vice president and **David A. Shepard** a director of Standard Oil Company (N. J.). A director since January 1, 1949, Soubry has spent all of the 40 years of his business career with Jersey and affiliated companies in the U. S. and abroad.

Shepard joined the Jersey organization in 1927 immediately following his graduation from Massachusetts Institute of Technology. He was made executive assistant to the president in 1949.

•

Robert L. Kidd, vice president of Cities Service Oil Company of Delaware, has been placed in charge of the company's Land and Geological divisions, as a part of a general realignment of executive duties and responsibilities in Cities Service Oil Company of Delaware and its subsidiaries. He will be assisted by **Ray Althouse.**

Kidd has also been named president of Cities Production Corporation, a wholly owned subsidiary of Cities Service Oil Company, which owns gasoline plants and about 10,000 barrels per day of crude production.

C. S. Mitchell was elected president of Cities Service Pipe Line Company, which handles crude and products pipe line operations.

Vice President **Sam Harlan** was elected president of American Gas Production Corporation, another wholly owned subsidiary, which produces about 250 million cubic feet of gas per day.

Walter C. Pew has been elected to the board of directors of Sun Oil Company, Philadelphia. Pew, who has had previous service as a director, joined Sun in 1922.

In Sun's Southwest Producing division, **Merle A. Sparks,** who recently returned from service with PAD in Washington, D. C., was named coordinator of joint operations. In the new position, Sparks will have headquarters in Dallas.

Before joining PAD as assistant to the director of the Production division, Sparks' only interruption in his 23-year career with Sun was for five years of military service in World War II. Sparks started with Sun in the Oklahoma division in 1928, after studying mechanical engineering at the University of Oklahoma. He was transferred to Beeville, Texas, in the Southwest division in 1938, and was working in the Corpus Christi and Beeville areas when called to World War II service. On his return to Sun in April, 1946, he was assigned to the Dallas office.

•

Dr. Carl Coke Rister has been appointed to the faculty of Texas Technological College, Lubbock, Texas, as "distinguished professor of history." Dr. Rister, a prominent petroleum historian, is author of the book, "Oil! Titan of the Southwest."

•

John E. McCleary has been appointed assistant manager of the Crude Oil department of Humble Oil & Refining Company, Houston. McCleary, a native of Oklahoma, received his bachelor's degree in business administration from the University of Oklahoma in 1932. He joined Humble in 1936.

John E. McCleary

Humble also announced several changes in the Production department. **Albert V. Lockett,** civil engineer in the East Texas division, has been promoted to district civil engineer of the Means district, West Texas division. **Leon B. Parker,** civil engineer in the Gulf Coast division, has been made district civil engineer of the Tomoconnor Construction district, Gas Construction division, in Southwest Texas.

D. J. Lewis, district civil engineer for Anahuac, has been made a supervising civil engineer in the Gulf Coast division. **J. H. Pittman,** district civil engineer for the Houston Construction district, went to Anahuac as civil engineer.

In another promotion, **S. J. Lewis,** senior civil engineer in the Gulf Coast division office, became assistant division civil engineer for East Texas.

•

Wilburn H. Seals has resigned from Continental Oil Company, Fort Worth, and is now a consulting geologist in Dallas.

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MEN IN THE INDUSTRY NEWS

A. N. Lilley

O. J. Dorwin

J. H. Pipkin

A. M. Ottignon

Oscar John Dorwin, general counsel for The Texas Company, has been elected vice president and general counsel. **A. N. Lilley,** general manager of foreign operations in the Eastern Hemisphere, has been made vice president in charge of that department. **James H. Pipkin** has been promoted from general manager of industrial and public relations to vice president in charge of that department. **A. M. Ottignon,** assistant to the president, was elected a vice president and will head the recently created Supply and Distribution department.

•

Charles C. Clark has resigned as gas reserves geologist for Texas Eastern Transmission Corporation at Shreveport to enter the practice of consulting geology and engineering with **Chester C. Clark** and **Robert B. Clark,** Shreveport. He had been with Texas Eastern the past three years, and before that was a geologist for The Carter Oil Company.

•

I. B. Tietze has been appointed general superintendent of the Crude Oil Pipe Line division of Phillips Pipe Line Company, subsidiary of Phillips Petroleum Company. Tietze continues as assistant to **W. H. Wallace,** vice president of Phillips Pipe Line.

Since joining Phillips in 1926, immediately following his graduation from the University of Missouri, Tietze has been engaged in pipe line construction and inspection, pipe line hydraulic and economic studies, and the protection of pipe lines from corrosion.

•

John S. Cruse, Jr., geologist for Amerada Petroleum Corporation, Tulsa, for the past 18 years, has resigned to become full time consultant for the J. D. Hancock interests in Dallas.

Frank O. Prior has resigned as president of Wyco Pipe Line Company and **R. E. Nelson, Jr.,** has been elected president to succeed him. **W. A. Bennett** has become vice president to succeed Nelson. **D. L. Rankin** has been made manager at Denver and also continues as secretary of the company.

Prior is executive vice president of Standard Oil Company (Indiana) at Chicago. Nelson is general manager of crude supply and product pipe lines for Standard at Chicago and continues in that capacity. Bennett has been general superintendent of Wyco. Rankin has resigned as manager of Standard's products pipe line department at Chicago.

•

Howard C. Pyle, California oil consultant, has been elected president and a director of Jergins Oil Company, Los Angeles. **Lowell Stanley** was elected chairman of the board.

For several years Pyle was chief production engineer for Union Oil Company of California. He later became vice president of the Bank of America in Los Angeles in charge of oil negotiations, and more recently was president of Continental Consolidated Corporation.

E. E. (Ernie) Pyles, vice president of Jergins Oil Company, has been elected a director. Pyles is a former president of Southwest Exploration Company; is currently a member of the Military Petroleum Advisory Board and the National Petroleum Council; and is also president of the San Joaquin Valley Producers' Association.

SECONDARY MODERN RECOVERY

TECHNICAL CONSULTING PRODUCTION ENGINEERING SERVICE, INCLUDING CORE ANALYSIS

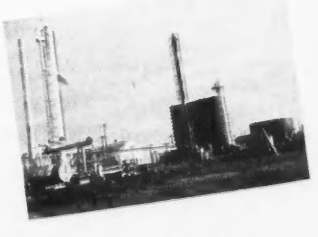
PRESSURE MAINTENANCE WITH GAS OR WATER

REPRESSURING WITH GAS OR WATER

Pressure Maintenance

Installation

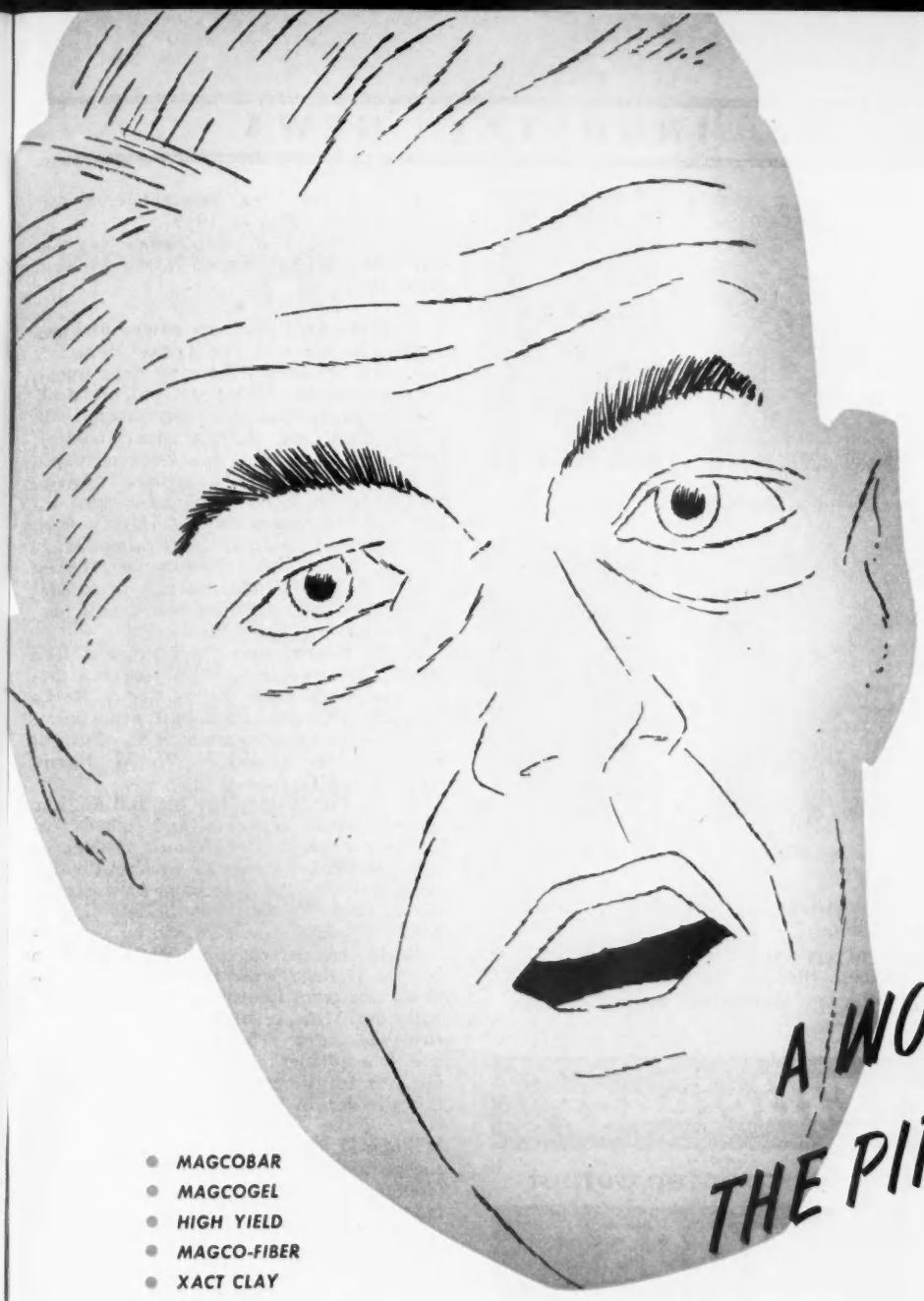
Combining Gasoline Extraction & Treatment



FISHER COUNTY, TEXAS

SURVEYS
ESTIMATES
DESIGN
INSTALLATION
SUPERVISION

PETROLEUM ENGINEERS
CABLE & STAPLES
WICHITA FALLS, TEXAS



A WORD ABOUT THE PIPE SITUATION

- MAGCOBAR
- MAGCOGEL
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DRILLING MUD SERVICE

DEALER

PROTECTIVE MUD CAN OFTEN REPLACE PROTECTION CASING, ALLOWING YOU TO DRILL MORE WELLS WITH YOUR PRESENT CASING ALLOCATIONS.

During 1951 enough steel was allocated to the petroleum industry to drill approximately 43,400 wells. Figures to date indicated that more than 46,000 wells will be drilled before the year ends.

It's a safe assumption that carefully planned drilling mud programs have played a big part in saving the steel necessary for the drilling of these 2600 extra wells.

There are many drilling conditions under which you can stretch your present casing allocations to include extra wells by using protective mud to replace protection casing. Ask your Magcobar field engineer to give you specific examples of how some wells can be drilled without protection casing.

MAGNET COVE BARIUM CORPORATION

ONE OF THE DRESSER INDUSTRIES

HOUSTON, TEXAS • MALVERN, ARKANSAS

W. C. McGee, Jr., general superintendent of Tennessee Gas Transmission Company, has been elected vice president and general superintendent. **Joe J. King**, formerly chief engineer, was advanced to vice president in charge of engineering, and was succeeded as chief engineer by **Edward S. Murray**, formerly assistant chief engineer.

W. C. McGee, Jr.

E. E. Miller, in addition to his duties as vice president of Northeastern Gas Transmission Company, will also be assistant chief engineer of Tennessee Gas.

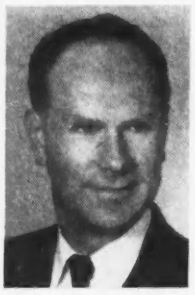
Earl McNeill was elected vice president of Tennessee Production Company, a subsidiary engaged in oil and gas exploration and production in the Southwest. He formerly was general superintendent.

Carl Myers, formerly Tennessee Gas treasurer, has been elected vice president in charge of the company's Commerce Building in Houston and of company insurance. **Cecil C. Johnson**, formerly assistant controller, was elected treasurer.

McGee is a graduate in civil engineering from Texas A. & M. College and joined TGT as chief dispatcher in 1944. King, a graduate mechanical engineer from the University of Texas, joined TGT in 1946 as assistant superintendent of compressor stations.

Edward S. Murray

Earl McNeill



Joe J. King

E. E. Miller

Myers was made controller of Tennessee Gas in 1944 and became treasurer in 1947. Johnston started as budget director in 1947 and has been assistant controller since the beginning of 1949.

Murray has been with Tennessee Gas since 1943, Miller since 1944, and McNeill since 1947.

•

S. T. McCardell has been named assistant division manager of The Texas Company's Louisiana division, Producing department. He has been general superintendent—drilling and production since November, 1948. **J. L. Shea, Jr.**, district superintendent, Houma, La., district, has been advanced to replace McCardell as general superintendent, while **J. H. Gibbens**, assistant district superintendent in the Harvey field, has moved up to district superintendent at Houma. Replacing Gibbens at Harvey field is **J. J. O'Brien**, assistant to general superintendent — drilling and production, division office, New Orleans.

R. T. Harris, who has been with The Texas Company since 1927, has been promoted to assistant to manager, Rocky Mountain division, Producing department. Harris, division accountant with offices at Denver, is succeeded by **R. M. Harris**, assistant division accountant.

R. T. Harris received his B.B.A. from the University of Texas, and joined Texaco as a clerk in the Houston accounting office in 1927. He rose to assistant division accountant in the Louisiana-Arkansas division in 1933. In 1945 he was named Rocky Mountain division accountant.

R. M. Harris was graduated from Mississippi College with the B.A. degree in 1936, and from Louisiana State University with the M.A. in business administration two years later. His first job with Texaco was that of clerk at Shreveport in 1938. He was transferred to the Rocky Mountain division in 1946.

•

William D. Davis has been named head of the geological department of Stanford Oil Company, Chicago. Davis will operate from the field office at Evansville, Ind. He was geologist for The Standard Oil Company of Ohio for many years.

•

John Daly, who was supervisor of the West Texas-New Mexico district of General Geophysical Company, has resigned to enter private practice as consulting geophysicist and geologist. Daly was previously with Honolulu Oil Corporation in charge of seismograph work in West Texas, New Mexico, Colorado and Mississippi. Prior to that, he was employed by Shell Oil Company as geologist and seismologist.

•

G. W. McCullough, former executive vice president and general manager of Phillips Chemical Company and Phillips Terminal Company, has been named chairman of the Operating Committee of Phillips Petroleum Company, replacing **J. E. Bogk** who resigned to enter private business.

•

A. R. Johnson, division industrial relations superintendent for Stanolind Oil and Gas Company in the North Texas-New Mexico division, Fort Worth, has been transferred to a similar post in the Rocky Mountain division, Casper, Wyo. He replaces **V. E. Staley**, who has been made a superintendent in producing operations.

Johnson's service record with Stanolind dates to 1926 when he joined Midwest Refining Company, a predecessor of Stanolind. He served in the Salt Creek area of Wyoming until 1933, when he transferred to Fort Worth.

Compressor Efficiency

has no equal in the race for greater output

VOSS VALVES have no equal

for they assure maximum compressor efficiency

It is a matter of record that every time an ordinary compressor valve is replaced with a specially designed VOSS valve, the immediate result is increased efficiency and greater output . . . and this record covers thousands of installations, as letters and reports testify.

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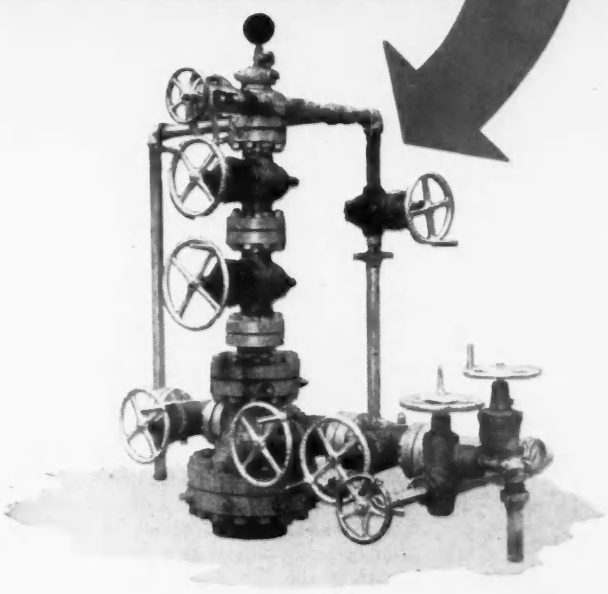
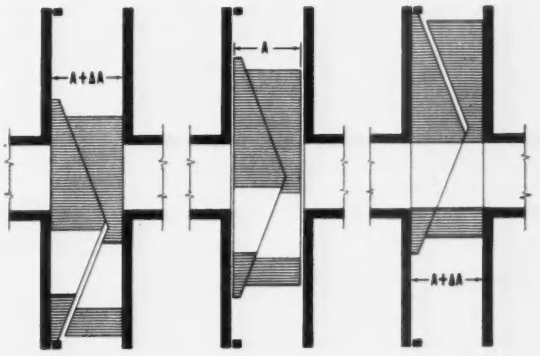


W-K-M Valves have a perfectly smooth bore which has about the same resistance to fluid flow as an equivalent section of smooth wall pipe. There are no cavities or projections to cause destructive turbulence or to collect sediment. The gate and the seats are fully protected against cutting or damage of any kind. These operating advantages are a result of the W-K-M Expanding Gate development which is illustrated below.



In closed position, the gate (left) and segment (right) seal tightly against both seats.

When opening or closing, the gate and segment are in neutral position, permitting free upward or downward movement of the gate assembly.

When open, the gate and segment again seal tightly against both seats and the bore of each lines up perfectly to provide a smooth, turbulence-free passage.

The W-K-M Expanding Gate design also provides free-running opening and closing under full rated pressure and gives extremely high seating pressures. For easy operation, W-K-M valves also have superfinished stems, double thrust bearings and precision ground stem threads.

These engineering and operational features are among the reasons why 80% of the world's high-pressure wells are controlled by W-K-M valves. Specify W-K-M when you want sure, positive control all over your Christmas Tree.

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Oversize Replaceable Seats • Pressure Seal Bonnet • Double Row Thrust Bearings on Stem • Internal Lubrication

Dixon H. Cain has been elected a director and president of Fifteen Oil Company, Houston, to succeed the late **David M. Picton, Jr.**

•

George H. Galloway has been named assistant chief geologist—programs, in the Tulsa general office of Stanolind Oil and Gas Company. **E. W. Price** succeeds Galloway as division geologist for the Central division, with offices in Oklahoma City. **E. L. Selk** replaces Price as district geologist for the Oklahoma district.

The new regional geologist for the Rocky Mountain division and Canada is **William S. McCabe,** who has been succeeded as division exploration superintendent by **John C. Johnston.** Johnston is replaced as division geologist by **Ross W. Craig.** All three are located in Casper, Wyo.

In the North Texas-New Mexico division at Fort Worth, **Russell Farmer** has been advanced to division consulting geologist, and **Thomas A. Hendricks** to division geologist.

•

William R. Tucker, Jr., has been advanced to assistant manager of the Insurance department of The Pure Oil Company, Chicago. Tucker, who has been with Pure 15 years, has been in the Insurance department ten years and a special assistant for five years.

Thomas E. Watson has joined the firm of Manhart, Millison & Beebe, Tulsa, as a geologist. A graduate of the University of Oklahoma in 1939, Watson was employed by Kingwood Oil Company and The Ohio Oil Company in the Illinois Basin until the beginning of World War II. Following his service in the Air Force he was employed as district geologist at Ardmore, Okla., for The Pure Oil Company, and more recently was division geologist at Tulsa covering several states in the Mid-Continent area.

Thomas E. Watson

•

F. M. McDaniel, formerly assistant production superintendent for Sunray Oil Corporation's Kansas district, has been made assistant district superintendent in charge of North and West Texas production activities in the Midland, Texas, area. McDaniel has been with Sunray since 1941.

Sunray also announced creation of a new operating area for its Spraberry wells formerly attached to the Odessa operating area. **John Binkley,** formerly a senior engineer in the Midland production office, is field superintendent in the Spraberry area.

Transfers and Promotions:

Clarence E. Rabb, assistant foreman in Magnolia Petroleum Company's Shreveport Producing district, has been promoted to production foreman and transferred to the company's Brownfield Producing district in West Texas. In the Kermit Producing district, **Ralph M. Cummins,** formerly assistant foreman, has been made production foreman. **Thurman Pinkerton,** formerly a petroleum engineer in the Gulf Coast division office, Houston, has been transferred to the Cushing Producing district, Drumwright, Okla. **Robert K. James,** petroleum engineer at Lake Charles, La., has been transferred to Gulf Coast division, Houston. **Warren D. Phelps,** petroleum engineer in the Cushing district, has been transferred to Oklahoma division office, Oklahoma City. **Mertz Ratliff** has been promoted to construction foreman in Magnolia's Kermit Producing district.

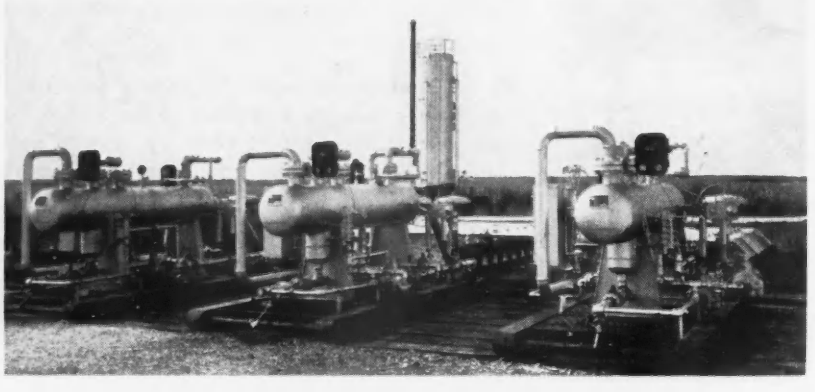
Loren L. Ware has been appointed division exploitation engineer, Sinclair Oil and Gas Company, and transferred from Oklahoma City to Tulsa with **James S. Kauffman,** senior geologist, succeeding him. **Jack H. Rankin,** assistant division superintendent, and **Charles F. Terrell,** division engineer, Production department, have transferred, respectively, from Independence, Kansas, to Oklahoma City, and from Tulsa to Independent. Other Sinclair changes include: **John J. Clark,** promoted from junior to intermediate petroleum engineer, transferred from Seminole, Okla., to Lindsay, Okla.; **Chris C. White,** Gainesville, Texas, promoted from junior to intermediate petroleum engineer; **Paul W. Shepherd,** promoted from junior to intermediate petroleum engineer and transferred from Lindsay to Kiefer, Okla.; **John W. Hemphill,** division engineer, transferred from Independence to Corpus Christi, Texas; **W. C. Summy,** assistant division superintendent, transferred from Oklahoma City to Corpus Christi; **Ralph E. McAvoy,** assistant district superintendent, transferred from Seminole to Oklahomo City; **William O. Batson,** district superintendent, transferred from Covington, Okla., to Ardmore, Okla.; **William F. Parker,** assistant district superintendent, transferred from Ardmore to Seminole; **Harold A. Randolph,** promoted from district foreman to district superintendent and and transferred from Columbus, Texas, to Covington; **James Cleven,** district foreman, transferred from Russell, Kansas, to Houston; **T. O. Harder,** district foreman, transferred from Burrton, Kansas, to Russell; **Bill R. Roark,** promoted from intermediate to senior petroleum engineer and transferred from Covington to Pampa, Texas; **Edwin L. Armour,** district foreman, transferred from Seminole to Olney, Texas; **Jess J. Heiskill,** district foreman, transferred from Henderson, Ky., to Seminole.

•

W. J. Edmund has been named chief petroleum engineer for **E. L. Doheny,** operator, Beverly Hills, Calif. Edmund resigned from Standard Oil Company of California after being employed as a development engineer in the San Joaquin Valley for the past 6½ years. He had previously spent 1½ years in Saudi Arabia. Edmund was graduated from Stanford in 1941 as a mechanical engineer and geologist.

ROLO WELLCHECKERS

PERMANENT AND PORTABLE OIL AND GAS SEPARATORS



This battery of three skid-mounted 4-5H-1607 Rolo Wellcheckers is one of five high-pressure installations with one of the major producers on the Gulf Coast. These units are arranged so that free water knockouts can be added at a later date by merely adding the controls.

Made in various sizes and working pressures to fit any operation, Rolo Wellcheckers enable operators to check well production daily, and secure accurate tax and royalty records. Installations of this type are approved by regulatory bodies.

Write, wire or phone today about your well testing and oil metering requirements, and let us work with you on your problems.

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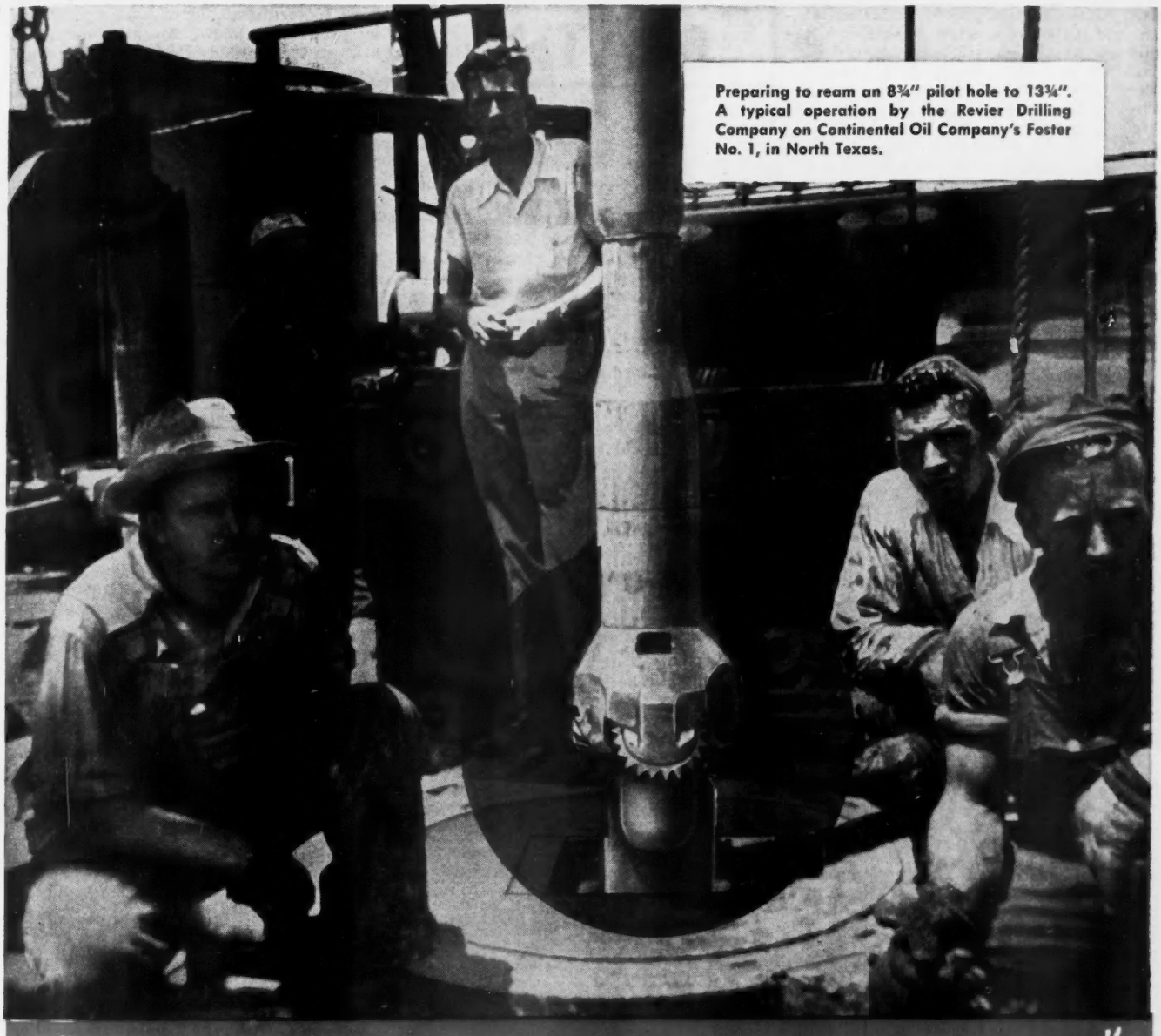

Preparing to ream an 8¾" pilot hole to 13¾". A typical operation by the Revier Drilling Company on Continental Oil Company's Foster No. 1, in North Texas.

"I'll use CP reaming bits every time"

Based on his long oil-field experience, J. B. Revier, drilling contractor, of Wichita Falls, Texas, states "for straight surface holes in fast time, I'll use CP reaming bits every time."

This is typical of the testimony of veteran drillers, who like the straight hole obtainable by reaming a pilot hole with a CP reaming bit.

CP Reaming Bits have three large, hardfaced cutter units which assure a true round hole, rapid cutting action and long life. Box down connection available to use rock bit instead of pilot blade, if desired. Reaming Bit sizes range from 10⅝" to 24".

Prompt service is assured in the Mid-Continent, Rocky Mountain, Canadian and Mexican fields.

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Oil Tool Division Office: One N. W. 16th Street, Oklahoma City, Oklahoma

In Canada: 10103 81st Avenue, So. Edmonton, Alberta, Canada • In Mexico: Mexico, D. F., Rosas Moreno No. 41; Tampico, Tamps., Apartado No. 174. Special Oil Tool Export Agent: E. F. Gahan, Inc., 500 Fifth Ave., New York 17, N. Y. (West Indies, Central and South America, exclusive of Mexico)

David Means Picton, Jr., 64, Houston oil man and attorney, died November 28 while on a hunting trip near Kerrville, Texas. Picton was an attorney for the late Will C. and Mike Hogg properties during their lifetimes, and was a member of the Harris County, Texas, and American Bar associations. He was president of the Fifteen Oil Company and Ingleside Land Company, and vice president and director of the Mikton Oil Company and Kirby Petroleum Company.

•

Max Jaffe, 68, Dallas oil man, died December 5. Secretary-treasurer of the Advance Oil Company and the Spandsco Oil and Royalty Company, Jaffe also had an interest in the discovery well in the East Texas field.

DEATHS

David S. Kilgour, 60, retired last July 1 as secretary of the Western Oil and Gas Association after 26 years service, died November 24 in Los Angeles. Kilgour joined the association, then known as the Chamber of Mines and Oil, in 1925, and served successively as auditor and assistant secretary before being named secretary in 1944.

•

Alvin T. Spikes, 50, owner of extensive interests in the Hugoton gas field, died November 25 in Garden City, Kansas.

Sven J. Nordstrom, 70, of Lafayette, Calif., internationally known inventor and valve manufacturer, died December 11 while visiting in Tulsa. He was born in Sweden and moved to the U. S. in 1901. For ten years he lived in Mexico, where he conceived the idea for the lubricated plug valve known as the Nordstrom valve. Nordstrom retired in 1947 but maintained his interest in company activities, continuing to work with his engineers on Nordstrom products.

•

Mrs. Joyce Richardson Wolfe, 48, one of the few women wildcatters in the oil business and believed to be the only one ever to discover a major oil field, died November 28 in Houston. Mrs. Wolfe brought in the Joyce Richardson field in Harris County, Texas, after drilling eight test wells. She also drilled three wildcats near the San Jacinto Monument, and was planning a fourth try at the time of her death.

•

Frank A. Billstone, 70, former treasurer and director of The Ohio Oil Company, died November 26 at Findlay, Ohio. On his retirement in 1946, Billstone had been with the company more than 42 years, rising from a clerical position to guide its accounting and financial affairs.

•

Grover Simpson, 59, vice president of Loffland Brothers Company from 1923 until his retirement about four years ago, died November 30 in Houston. Simpson was in charge of Gulf Coast production for the company for about 15 years. At the time of his retirement in 1946 he sold out his interest in the firm. He was a principal developer of the North Thompson oil field at Rosenberg, Texas.

•

Sullivan G. Ashby, 43, independent oil operator and an associate of the late Lloyd Noble in the Samedan Oil Corporation, died December 3 at Tulsa.

•

Erik U. Garpner, 50, geophysical consultant for Seismograph Service Corporation, Tulsa, died November 25 in Los Angeles. A native of Sweden, he had lived in Tulsa for 22 years before moving to the West Coast several months ago. He had been with Seismograph Service two years.

•

Harold T. Williams, 59, Northern division superintendent for General Petroleum Corporation's Pipe Line department, died December 1 at Santa Barbara, Calif.

•

William C. Baker, 69, veteran Oklahoma oil man, died November 20 in Tulsa. He was co-founder of the old Pennant Oil and Gas Company and at one time was chief oil scout and superintendent of the scouting and leasing department of the old Roxana Petroleum Company.

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carefully controlled inspection **FOR QUALITY**
bored and threaded on special machines **FOR ACCURACY**
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HARRISBURG Seamless Steel Pipe Couplings . . . made to A.P.I. and A.I.S.I. specifications . . . are bored and threaded on special machines for accuracy of form, height, angle, and lead.

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99 YEARS IN PENNSYLVANIA'S CAPITAL

Associations

General Mid-Continent Group Elects New Slate of Officers

William T. Payne, president, Big Chief Drilling Company, Oklahoma City, was elected president of the General Mid-Continent Oil and Gas Association at the annual meeting of the directors in Tulsa. He succeeds Jake L. Hamon, independent operator, Dallas. R. B. Anderson of the W. T. Waggoner Estate, Vernon, Texas, was elected first vice president, and Clarel B. Mapes, Tulsa, was re-elected secretary-treasurer.

State vice presidents chosen were T. H. Marshall, Oklahoma City, president of the Kansas-Oklahoma division of the association, vice president for Oklahoma; W. G. Tierney, Derby Oil Company, Wichita, for Kansas; R. F. Windfohr, Nash, Windfohr and Brown, Fort Worth, for Texas; A. H. Weyland, Arkansas-Louisiana Gas Company, Shreveport, for Louisiana; C. H. Murphy, Jr., Murphy Oil Corporation, El Dorado, Ark., for Arkansas; E. B. McGehee, independent operator, Jackson, for Mississippi; James L. Duffy, James L. Duffy Company, Grove Hills, for Alabama; F. A. Calvert, Jr., Calvert Drilling Company, Olney, for Illinois.

Fractured Zone Production Is Topic for AAPG Meeting

"Production of Oil and Gas from Fractured Reservoirs" will be the theme of the symposium to be held by the American Association of Petroleum Geologists at the annual meeting in Los Angeles in March, 1952. This subject is of considerable current interest because of the development of the Spraberry zone in West Texas. Geologists in that area believe that much, if not all, the oil and gas found in that zone are in fractured beds. (One geologist has estimated that one-third of the world's crude oil reserves are found in fractured reservoirs.) One of the oldest oil fields in the world—Florence, Colo.—produces from fractured shales. Fractured limestone has been a source of considerable production in Venezuela, Canada and the Middle East. An attempt will be made to include a discussion of each of these types of accumulation at the Los Angeles meeting.

Battelle Institute Conducts Study of New Drilling Methods

Drilling Research, Inc., a non-profit corporation whose members represent more than half of the world's oil-well drilling capacity, has initiated at Battelle Institute, Columbus, Ohio, a study of drilling methods.

"It is vital that the cost of drilling an oil well be reduced," said Dr. J. V. Pennington of Houston, Texas, technical director of Drilling Research, Inc., "or vast reserves of marginal production potential cannot be drilled and higher prices for all petroleum products. . .will be inevitable.

"We have asked Battelle to disregard all known drilling techniques and to delve into the realm of the unconventional and 'the impossible.' We are also setting up a basic long-term research plan to insure a healthy progress in years to come."

Payne Elected to TIPRO Post

Bryan W. Payne, Tyler, Texas, has been elected president of Texas Independent Producers and Royalty Owners Association. He succeeds R. L. Foree who has joined the PAD in Washington.

Petroleum Production Pioneers is sponsoring a series of historical markers to memorialize sites and events significant in the history of the petroleum industry in California. The first monument, pictured, is at Fellows, Calif.

Gulf Engineering Executive Elected 1952 ASME President

Reginald J. S. Pigott, director of the engineering division of Gulf Research and Development Company, Pittsburgh, has been elected president of The American Society of Mechanical Engineers for 1952.

Director of engineering research for the Gulf Oil Corporation subsidiary since 1929, Pigott is in charge of research and design of production techniques, tools and equipment, laboratory buildings, operation of shops and drafting rooms, and design and fabrication of test equipment.

OIIC Advances D. R. Waugh; Announces Field Assignments

Donald R. Waugh, of Boston, has been promoted to national supervisor of field operations for the Oil Industry Information Committee. Waugh, district representative in New England for 4½ years, succeeds James S. Haskins, resigned.

A second supervisory position in the New York headquarters has been filled by the promotion of Ben Ames, Cincinnati, who will be assistant supervisor of field operations.

Other changes in the field staff include the promotion of John B. Goodman, assistant district representative in the New York-New Jersey district, to succeed Waugh at Boston; and J. W. Lenon, assistant district representative in the Kentucky-Ohio-Tennessee district, to succeed Ames in Cincinnati.

THE 1952 BOARD OF DIRECTORS of the Petroleum Electric Power Association is pictured at the organization's annual meeting in Houston. Seated, left to right, are Fred B. Clark, Arkansas Power and Light Company, El Dorado, Ark.; W. L. Pearson, Southwestern Public Service Company, Lubbock, Texas; O. J. Frandsen, Public Service Company of Oklahoma, Tulsa; J. W. Lambert, Southwestern Public Service Company, Borger, Texas; T. E. Graham, Oklahoma Gas and Electric Company, Oklahoma City. Standing, left to right: R. N. Crossman, Jr., Houston Lighting and Power Company, Houston; W. M. Larkin, Gulf States Utilities Company, Lake Charles, La.; J. E. Moody, Southwestern Gas and Electric Company, Shreveport; D. S. Coffman, Texas Power and Light Company, Dallas; Ned W. Beaudreau, Central Power and Light Company, Corpus Christi.

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ASSOCIATIONS

API PUBLIC RELATIONS got a deserved plaudit when the American Public Relations Association awarded its "Certificate of Public Relations Achievement" to the Oil Industry Information Committee. Emmett Howard, division manager of American Oil Company, Philadelphia, and chairman-elect of the Middle Atlantic district of OIIC, accepts the award presented by Dr. Paul Douglass, president of American University and chairman of APRA's committee on awards. Paul Bolton, also a member of the committee, looks on.

New York Oil Women Organize Desk and Derrick Association

The Desk and Derrick Club of New York City, representing 21 oil companies and associated organizations, has been organized with Carol Eberhart of The Texas Company, one of the founders, as its first president.

Other officers of the group are Gertrude King, Gulf Oil Corporation, vice president; Frances Neff, Shell Oil Company, recording secretary; Edna Hurry, Standard Oil Company (N. J.), corresponding secretary; Doris Adams, Esso Standard Oil Company, assistant corresponding secretary; and Muriel McNab, California Commercial Company, secretary-treasurer.

Petroleum Division Organized By Southwest Manufacturers

Formation of the Petroleum Division of the National Association of Manufacturers' Southwestern Regional Advisory Committee was announced by Robert L. Humphrey, regional manager.

John W. Newton, vice president of Magnolia Petroleum Company, Beaumont, Texas, has accepted the temporary chairmanship of the Petroleum Division's Advisory Committee.

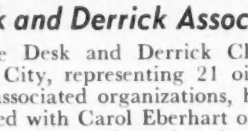
Five Industry Men Are Elected Controllers Institute Members

New members of the Controllers Institute are Harold D. Osborn, assistant comptroller of General Petroleum Corporation, Los Angeles; Glenn T. Bodman, assistant controller of Continental Oil Company, Ponca City, Okla.; William H. Hendrickson, vice president and secretary-treasurer of Texas Gulf Producing Company, Houston; Elgon K. Faulds, comptroller and assistant treasurer of H. C. Smith Oil Tool Company, Compton, Calif.; and John L. Pausch, controller of Dresser Equipment Company, Columbus, Ohio.

Intermountain Geologists Elect Graham S. Campbell

Graham S. Campbell of Phillips Petroleum Company, Salt Lake City, Utah, has been elected president of the Intermountain Association of Petroleum Geologists.

Vice president is Irwin W. Clark, Standard Oil Company of California, and treasurer is J. R. Boshard, Sun Oil Company. Frank J. Adler, Phillips Petroleum, is secretary of the group. All the new officers are from Salt Lake City.



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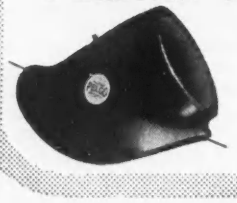


Companies in the News

WARREN PETROLEUM CORPORATION has acquired The Devonian Company as a wholly-owned subsidiary. **D. L. Connelly** of Houston, president of Warren Oil Corporation, has been elected chairman of the board of The Devonian Company, while **E. S. Calvert** of Tulsa has been re-elected president and a director and named a vice president and director of Warren Oil Corporation.

H. F. Beardmore and **P. L. Lyons** of Houston, vice presidents and directors of Warren Oil Corporation, have been elected vice presidents and directors of The Devonian Company.

J. F. Anderson of Houston has been elected a director of Warren Oil Corporation and The Devonian Company, in charge of exploration, while **Harry Dean** of Tulsa has been re-elected secretary and treasurer of Devonian.

W. K. Warren, president of Warren Petroleum Corporation, announced that the two wholly-owned producing subsidiaries of Warren Petroleum will be operated as separate companies, although the producing and drilling activities will be consolidated, with Beardmore in charge of the southern division, and Calvert in charge of the northern division.

•

DEEP ROCK OIL CORPORATION has moved its Oklahoma City area land and exploration office into new quarters at 930 Apco Tower. The office is headed by **L. L. Crozier**, area landman, and **O. E. Gram**, area geologist. Activities in Oklahoma, northern Arkansas and the northern part of Texas Panhandle are covered from the Oklahoma City office.

•

ZEPHYR DRILLING CORPORATION is the new name of the former Zephyr Corporation. The firm operates ten rotary rigs in the southern Oklahoma and West Texas area, and has offices in Tulsa and Midland. **F. G. McClintock** is president.

•

STANOLIND OIL AND GAS COMPANY's area office at Wewoka, Okla., was transferred to Duncan, Okla., effective January 1, 1952. The office will continue to supervise drilling and producing operations in Southern Oklahoma, including 284 producing wells and 16 drilling wells in Cotton, Stephens, Garvin, Carter, Pontotoc, Marshall and Coal counties.

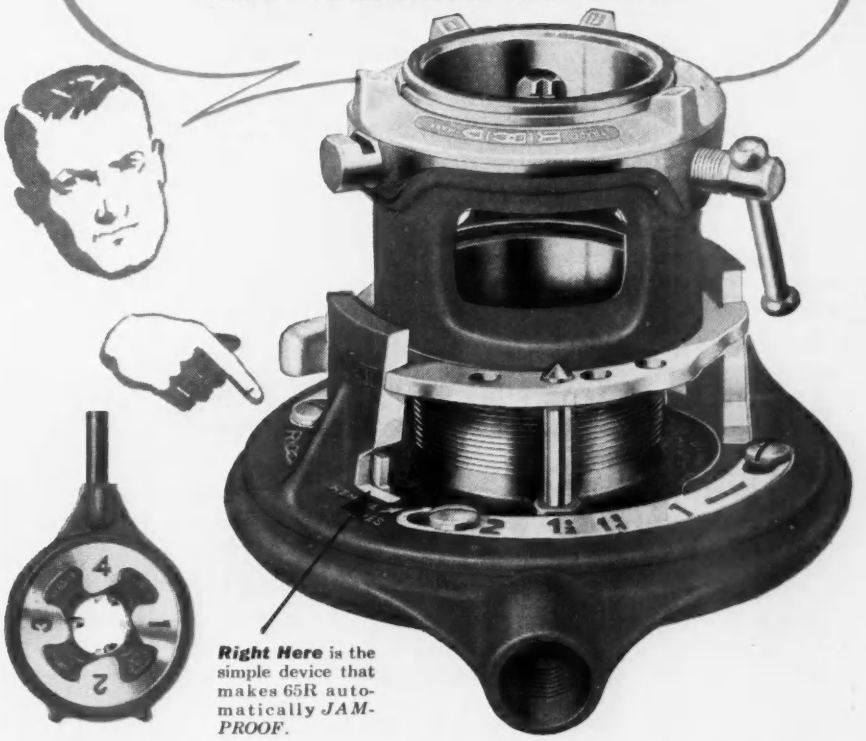
Don H. Crall, field superintendent, will be in charge of the Duncan area. Approximately 20 engineers, clerks, stenographers and their families will be involved in the move.

•

STANFORD OIL COMPANY, Chicago, has opened New York offices in the Empire State Building. The company, which is engaged in drilling and production in the Tri-State area of Illinois, Indiana and Kentucky, maintains headquarters in Chicago and an office in Evansville, Ind., for geology, land and production departments. It is headed by **Kenneth J. Stanford.**

You can't jam the new RIDGID 65R

Really streamlined pipe threading with this RIDGID self-contained die stock



Right Here is the simple device that makes 65R automatically *JAM-PROOF*.

● You don't have to watch it—lead screw can't jam on workholder. New jam-proof drive plate automatically kicks out driving ratchet pawl when standard length thread is cut. Your recent model 65R easily converted—just buy new drive plate, put in place of old plate. Perfect threads on 1″ to 2″ pipe with one set of 4 high-speed steel dies—sets to pipe size in 10 seconds, mistake-proof self-centering workholder sets instantly! Buy the new jam-proof RIDGID 65R at your Supply House.

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THE RIDGE TOOL CO. • ELYRIA, OHIO

EQUIPMENT AND SERVICE SUPPLIERS' NOTES

M. O. Johnston Sells Service Firms To Group Headed by W. B. Taylor

M. O. Johnston has sold his group of operating oil field service companies to Johnston Testers, Inc., of Houston, but continues as a substantial stockholder and a director in the corporation which purchased his operating organizations.

W. B. (Bill) Taylor heads Johnston Testers, Inc., as president. Other officers are J. E. Smith, O. W. Ward and T. M. Johnston, vice presidents; H. F. Junker, secretary-treasurer; and J. H. Hambrick, Jr., assistant secretary-treasurer.

Directors of the new corporation are Taylor, M. O. Johnston, E. C. Johnston, Junker, Smith, L. B. Martin, Ed Rotan and Richard J. Kneedler.

Taylor began his oil field career in Eldorado, Kansas, and in the middle 1930's joined the M. O. Johnston organization. Since 1942 he has been vice president and general manager of Johnston Oil Field Service Corporation, an M. O. Johnston organization which headquartered in Houston and operated throughout the Gulf Coast and Mid-Continent areas.

W. B. Taylor

M. O. Johnston

The M. O. Johnston group consisted of M. O. Johnston Oil Field Service Corporation, Los Angeles, operating in California and Rocky Mountain states; Johnston Oil Field Service Corporation, Texas; M. O. Johnston Oil Field Service, Ltd., Edmonton, Alberta, Canada; and M. O. Johnston Oil Field Export Corporation, Los Angeles.

M. O. Johnston, working with his brother, the late Edgar C. Johnston of Longview, Texas, pioneered in drill stem testing in the 1920's.

International Cementers Firm Name Is Changed to BJ Service, Inc.

E. S. Dulin, president of Byron Jackson Company, announced that at a directors meeting of International Cementers, Inc., (now a wholly owned subsidiary), the name was changed to BJ Service, Inc., and as soon as the necessary permission is obtained from the various states in which BJ Service, Inc., is qualified, all operations will be conducted under the new name. Steps were also taken to amalgamate certain oil field services now operated as a division of Byron Jackson Company with the new service subsidiary.

BJ Service, Inc., has opened new service facilities at Seagraves and Rankin, Texas. A station opened at Williston, N. D., will serve the new Williston Basin area.

Emsco Derrick & Equipment Elects Powell Executive Vice President

William T. Powell has been elected executive vice president of Emsco Derrick & Equipment Company, a new position created by Emsco's board of directors. He has been with Emsco 14 years, and for the past nine years has been vice president.

William T. Powell

A native of Wales, Powell was graduated from the South Wales and Monmouthshire School of Mines in 1923, holds a mechanical engineering certificate of City and Guilds of London Institute, and is a member of ASME. He came to the U. S. in 1929 and became a citizen in 1935. In the U. S., he has been with C. & A. Mining Company, Ajo, Ariz.; Dicalite Company, Torrance, Calif.; Kelco Company, San Diego, Calif.; and American Potash & Chemical Corporation, Trona, Calif.

Powell joined Emsco in 1937 in the Fabricated Plate division. He was manager of the War Materials division before his election as vice president in 1942.

Rocky Mountain Distributor Is Appointed for Oil Base Products

Oil Base, Inc., Compton, Calif., has appointed English Oil Tool Company, Casper, Wyo., as the exclusive distributor for sales and service of Black Magic, White Magic and other Oil Base mud products in the Rocky Mountain area.

English Oil Tool Company is owned and operated by Glenn English. He is assisted by Don Rogers, who undertook training at the Oil Base Compton plant on the use and maintenance of oil base drilling fluids, oil emulsion muds and additives.

A second office of English Oil Tool Company has been established at Powell, Wyo., under the supervision of Dick Lynch.

Greatest Name in Cable Tools

Acme

TRUSTWORTHY SINCE 1900

PETROLEUM EQUIPMENT SUPPLIERS MEMBER ASSOCIATION

. . . to-be-Sure — Always Ask for Acme's Alloy Bits...

A most reasonable extra FIRST cost buys you ½-century's biggest bit buy. Delivers 50% or more actual in-hole action than any "regular" bit. Acme "Drilmor" ALLOY meets the increasing demand for a new type bit fully capable of cutting HARDEST formations; assuring more in-hole time.

Write NOW for Alloy Bit's full facts and your copy Acme's latest Cable Tool Catalog — containing proper field treatment of bits.

Another feature (saving wasted out-time) is that Acme's Alloy Bit can be dressed and tempered in the field. And without special equipment; like "regular" bits. EXTREME, deeper penetrating hardness makes Acme's non-competitive Bits hold cutting edge, wear longer, resist battering, even in toughest going. They're longer life bits for your longer profit.

Fig. 108AA. Acme Alloy Bit. 51-years' specialized "know-how" makes it worth more to YOU.

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EQUIPMENT and SERVICE SUPPLIERS' NOTES

Hughes Tool Service Limited Names Hood Canadian Operations Manager

R. D. Hood

R. D. Hood has been promoted to manager of Canadian operations for Hughes Tool Service Limited, with headquarters at 7515 104th Street, Edmonton, Alberta. Hood has served in several capacities with Hughes Tool Company in the U. S. since 1934, having recently moved to Canada from Oklahoma City. He has made periodic trips to Canada since 1949 in connection with operations of the company.

W. H. Cook Heads Gulf Coast Office Of Eastman Oil Well Survey Company

W. H. Cook

W. H. (Windy) Cook has been appointed Gulf Coast division manager for Eastman Oil Well Survey Company at Houston. Cook has been with Eastman since 1938, and was formerly Gulf Coast division sales manager. He is a graduate of Rice Institute.

J. C. (Hap) Staton, who has been in the division the past ten years, continues as general field superintendent.

Lane-Wells Promotes A. B. Winter to Assistant Chief Electrical Engineer

A. B. Winter

Lane-Wells has promoted A. B. (Burm) Winter, formerly division radioactivity engineer at Houston, to assistant chief electrical engineer. Winter will be concerned with specification, design and completion of electrical phases of Lane-Wells equipment, along with the acquisition, installation and maintenance of it. He will also investigate operating problems and recommend changes, corrections, inspection, and testing of electrical equipment. Most of his work will be in the fields of electrical and radioactivity well logging services.

Milo M. Hawthorne succeeds Winter at Houston, and will supervise all division radioactivity equipment and assist in the selection and training of radioactivity personnel. Hawthorne joined Lane-Wells in 1947 as a rigman, and worked in the field until 1950 when he became district radioactivity engineer at New Iberia, La.

His business paper . . . of course

No man who takes his job seriously takes his business paper lightly. The **Best Informed Men in your Field** read every issue . . . straight through. They can't afford not to. Who *can*, in these fast-moving times? New ideas, new products, new methods, new techniques crop up one-a-minute. You *need* the continuous touch with facts and news and "how-to" that only your business paper provides. The editors continuously scout the field for you; the advertisers report new products . . . new profit angles. Cover-to-cover reading makes *you* one of the **Best Informed Men in your field,** too.

Did you know this business paper is a member of the Associated Business Publications? It's a *paid*-circulation paper . . . which means the editors must keep their magazines well sold and well read. They meet other editors in clinics, conferences and courses . . . work to make a good paper better—to serve you in more ways. Your business paper is worth every minute you spend with it!

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WORLD'S LARGEST OIL INDUSTRY PUBLISHERS

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CENTRIFUGE

You can maintain your required speed for the full period of the test with much less effort. Curtin centrifuges, proven world-wide, are heavy duty, rigidly constructed, and extremely simple in design. Illustrated bulletin, giving full details, available upon request.

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HOUSTON .... NEW ORLEANS.

STEEL Kelley PRODUCTS

Do You Need a Good New Source of Metal Stampings for Defense Contracts?

Kelley has the facilities, the know-how, and the men to do your job and to do it right. From start to finish Kelley is your one source—to help you engineer stampings, to design and make the tools, and, most important, to deliver the job to your specifications on time. Kelley cut its teeth in oilfield equipment, uses that experience to make your job better.

Write for this booklet, a complete description of Kelley, shows work done, lists machines, shows how Kelley will help you.

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Houston, Texas

EQUIPMENT and SERVICE SUPPLIERS' NOTES

NEW ADMINISTRATIVE HEADQUARTERS of Baroid Sales Division, National Lead Company, are in this new building at 2404 Danville Street, Houston. The structure contains laboratory facilities for organic and analytical chemistry, mud analysis, and instrument design; foundry and training laboratories, mills for grinding raw materials, complete photographic and printing facilities, and a technical library. About 165 Baroid technicians and engineers, scientists in the research department, members of the sales staff, and clerical and administrative personnel work in the new building.

Seismograph Specialist Organizes C. E. Hendricks Company in Tulsa

C. E. Hendricks, formerly a director, as well as the vice president in charge of engineering for Century Geophysical Corporation, has resigned to organize the C. E. Hendricks Company, Tulsa. The new firm will deal with maintenance, servicing and repair of seismograph instruments and will serve as consultants for engineering problems relating to seismology.

C. E. Hendricks

Midwestern Geophysical Laboratory, Tulsa, has retained Hendricks as consulting geophysical engineer, and also as a seismograph equipment sales representative.

C. J. Rollo Receives Promotion To Vice Presidency of Brown & Root

The promotion of C. J. Rollo to vice president of Brown & Root, Inc., Houston, was announced by Herman Brown, president. Rollo has been manager of the company's industrial building construction program, and has been with the firm since 1940.

Rollo's appointment follows a reassignment of duties among the Brown & Root staff following the accidental death in early September of W. A. Woolsey, the firm's executive vice president.

Treybig Heads Seismic Exploration Contracting Company in Louisiana

Louisiana Exploration Company, a seismic exploration contracting company, specializing in salt dome and fault problems common to Gulf Coast geophysics, has opened headquarters in New Iberia, La.

B. H. Treybig, Jr.

B. H. Treybig, Jr., head of the organization, attended Rice Institute, Houston. He joined The Texas Company in 1932, and did seismic exploration work in the U. S., South America and Canada. He was geophysical supervisor for the Louisiana division from 1944-1950 and assistant to the geophysical division manager until his recent resignation to form Louisiana Exploration Company.

TOP OFFICIALS of the H. C. Price Company gathered in Bartlesville, Okla., to help celebrate the company's 30th anniversary. It was the first time in the organization's history that all of its superintendents had met together. Front row, left to right, are M. J. Lane, Somastic division superintendent; C. E. Shivel, C. R. Ice, R. K. Shivel and G. A. Reutzel, Pipe Line division superintendents; and Nelson VerSoy, Somastic division superintendent. Second row, left to right, are R. P. White, Somastic division manager; J. S. Dewar, Somastic division vice president; H. C. Price, president; John M. Thomas, Pipe Line division manager; and J. B. Harshman, Pipe Line division vice president.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Frost Airborne Survey Corporation Will Have Headquarters in Tulsa

Virgil Kauffman, president of Aero Service Corporation of Philadelphia, and C. H. Frost, president of Frost Geophysical Corporation of Tulsa, have organized Frost Airborne Survey Corporation with headquarters in Tulsa.

Dr. Joseph A. Sharpe, vice president of Frost Geophysical Corporation since 1945, has been selected president of the new company whose principal activities will be the conduct of and interpretation of aeromagnetic surveys for the oil industry and the development of improved aeromagnetic instruments, procedures and interpretation.

The new corporation is licensed, under certain basic patents issued to Gulf Research and Development Company of Pittsburgh, to perform aeromagnetic surveys for oil structures and minerals.

F. L. LeBus Organizes International Wire Line Spooling Promotion Firm

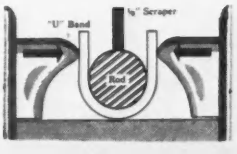
F. L. LeBus, Sr., owner and co-owner of many patents and patents pending on grooving for hoisting drums and wire line spooling methods, has organized LeBus International Engineers, Ltd., with executive offices at 300 Wichita National Bank Building, Wichita Falls, Texas. The new firm was established exclusively to promote and develop wire line spooling methods.

ONE OF SEVERAL groups of oil executives, engineers, buyers and field men who have visited the modern sucker rod plant operated by the D+B Division of Emsco Derrick & Equipment Company at Garland, Texas, is pictured. Front row, left to right, are C. K. Trease, CSCO, Oklahoma City; Eugene Fisher, superintendent, Stanolind Oil and Gas Company; J. A. Queen, petroleum engineer, Continental Oil Company; Chester U. Burk, division mechanical engineer, Continental. Back row: F. A. Lichtenheld, division engineer, Cities Service; Joe F. Cook, D+B Division; John Miller, superintendent of production, Peppers Refining Company; H. T. Oliphant, well servicing foreman, Phillips Petroleum Company; W. B. Buck, superintendent, Phillips; and J. R. Govett, petroleum engineer, Continental.

NO PARAFFIN TOO HEAVY

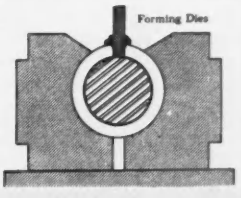
TO WHIP CRALL SPIRAL SCRAPERS

CRALL Spiral Paraffin Scrapers will keep any well free from paraffin. Even in areas where paraffin is unusually heavy, CRALL Spiral Scrapers keep the well cleaned efficiently. Save work-over servicing and stripping jobs, with CRALL Scrapers and you'll be time, man power and money ahead every time.



Cross section showing "U" band being die-formed around rod to the scraper blades.

PASS SCRAPERS EVERY STROKE UP AND DOWN



Cross section showing band held under pressure around rod while ends of band are shrink-grip attached to scraper blade.

- Scrapers alternate—one right, one left—eliminating tendency of the rod to unscrew.
- Scrapers are attached at our fabricating plants and stocked at supply stores.
- Made of thick, mild steel. Sizes to fit 2" and 2½" tubing. Will fit any make of sucker rod. New or used.
- Scrapers are light in weight. The extra load to your rod string is negligible, 150 to 160 lbs. per 1,000 ft.
- No gadgets to fool with. No maintenance cost. Scrapers will not harm rods or tubing.
- Scrapers are placed close enough so they pass or meet each other with each reciprocation up and down.
- Scrapers fit perfectly. Neither scrapers nor bands are welded to the sucker rod.
- In every case CRALL Spiral Paraffin Scrapers pay for themselves many times over.

Order CRALL Spiral Scrapered Rods from your Supply Store, or write, wire or phone . . .

PETROLEUM SPECIALTY CO.

P. O. BOX 1640 PAMPA, TEXAS

Manufacturing, Fabricating Plants and Sales Offices

Pampa, Sundown and Odessa, Texas — Casper, Wyoming — Oklahoma City and Chickasha, Okla.

UNITED GEOPHYSICAL COMPANY has completed this $750,000 plant in Pasadena, Calif. The buildings house the company's five divisions, Research and Development, Engineering and Supply, Operations, Interpretation and Computation, and Finance.

H-F Tuff-Temper Stainless Ball & Seat
Outer Traveling Tube
Standing Barrel Tube
Inner Traveling Tube
Plunger Valve
No-Go Ring
3-Cup Bottom Hold-Down
2" x 1¼" and 2½" x 1¾" sizes
12', 15', 18' and 25' lengths

H-F

3 TUBE

Rod Pump

for SANDY WELLS
ABRASIVE FLUIDS
HIGH TEMPERATURES

The design and operating principle of three reciprocating tubes make this special insert pump especially efficient in wells with excessive float sand, dirty fluid, or with high sub-surface temperatures that cause close-fitting metal-to-metal plunger pumps to stick. The plunger is free-falling which allows a greater strokes-per-minute pumping rate without being hard on the rods. To compensate for the loose fit, part of the production fluid is forced into annular spaces and utilized as a sealing medium around the plunger. A special no-go ring on the standing valve cage prevents the pump from becoming sanded in when idle. The pump is made to A.P.I. specifications throughout, including the retrievable valves and the standard-size balls and seats which are easily obtained. Available in either regular or on-and-off types. For a hard to pump well, or as a good, all-around pump for an average well, you can depend upon this pump to make good production. Ask at your supply store, or write us direct, for descriptive literature.

H·F

HARBISON-FISCHER
Mfg. Co. • Box 64 • Ft. Worth, Tex.
"best pumps in the oil patch"

Well Equipment Manufacturing Names Eli Parker to South Louisiana Area

Well Equipment Manufacturing Corporation has appointed Eli W. Parker its South Louisiana sales representative. Parker has been engaged in oil field sales and service since 1936 when he began with the production and drilling departments of the Texas Company in South Louisiana. He subsequently worked for an oil tool manufacturer and a supply company, and for the past three years has worked as service engineer for a drilling mud company. Before moving to Lafayette, La., where he has his headquarters, Parker completed a training course in the WECO Houston plant.

Eli W. Parker

Dowell Incorporated Names Polk General Manager and a Director

A. C. Polk, Jr., assistant manager of Dowell Incorporated, has been named general manager and a member of the board of directors. He has been with the company since 1941.

Polk, before his promotion to assistant manager in 1948, was Houston district manager. He had previously been at Levelland, Texas, Shreveport, and Lafayette, La.

A. C. Polk

Dowell also announced the opening of a new operating station in Williston, N. D., with J. A. McClure, former sales engineer at Salem, Ill., in charge. McClure, a graduate engineer from Oklahoma A. & M. College, has been with Dowell since January, 1949. He will be assisted at Williston by R. L. Monfort, from Great Bend, Kansas.

Continental Shifts Field Men

Cooper Vaughn, manager at McAllen, Texas, for Continental Supply Company, has been transferred to Alice, Texas, in the same capacity. M. H. Johnson, formerly at Corpus Christi, has been named manager at the McAllen, Texas, store.

Contracting Firm Organized

J. H. (Herb) Smith and Marvin Donaho have organized the pipe line construction firm of Smith-Donaho Contracting Company, with offices at 205 North West Seventh Street, Fort Worth.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

Ralph Nation

Charles Stephens

Beaumont Cement Sales Company Is Purchased by Mud Products, Inc.

The Beaumont Cement Sales Company, with offices in the Pierre-Marquette Building in New Orleans, has been purchased by Mud Products, Inc., Tulsa. The new management of Beaumont Cement Sales includes Ralph Nation, vice president and general manager, formerly the Oklahoma division manager for Mud Products; and Charles Stephens, secretary-treasurer and office manager, formerly Tulsa office manager for Mud Products. Other sales and operating personnel of the purchased firm remain unchanged.

Properties of Beaumont Cement Sales include 23 warehouses and three warehouses now under construction. The company operates four LCT boats for deliveries in coastal waters, and uses two Cessna float-equipped planes for checking and expediting orders.

New Dallas Branch Is Opened by Viking Pump; Phillips in Charge

A new service branch for the Oklahoma-Texas-New Mexico area has been opened at Dallas by Viking Pump Company. O. W. Phillips, associated with the company for the past 22 years and production manager of the Cedar Falls, Iowa, factory for the past seven years, has been named manager of the new branch.

O. W. Phillips

Viking's Dallas sales and service center is at 2175 West Commerce Street.

Baker Oil Tools Moves All Offices To New Location in Los Angeles

The entire office facilities of Baker Oil Tools, Inc., have been moved from Vernon, Calif., to the new plant and office building at 7400 East Slauson Avenue, Los Angeles.

Baker's plant facilities will be moved early in 1952, and in the meantime remain at their present location, 2959 East Slauson Avenue, Huntington Park, Calif.

Chemical Office Opened

The Gulf Coast office of the Petroleum Chemicals Division, E. I. du Pont de Nemours & Company has been moved to Suite 705-709 of the Commerce Building in Houston.

Here's some "FIRST" Friends You should Know

ELMO THOMPSON

JOE BYRD

HARRY LANE

DICK WAGONER

DEAC RHODES

At the beginning of 1952

May we wish the very best to You–

and You ...and You ....

and You... and YOU!

Our humble thanks for the business You've given us.....

And we're proud of the new heights

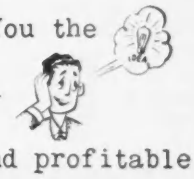
to which it's driven us!

May this year bring You prosperity

And - what is even more of a rarity -

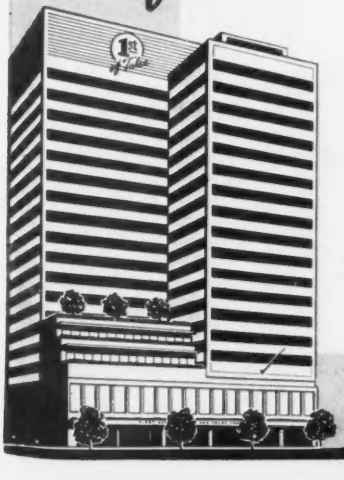
Real Happiness!

In Tulsa - we pledge that we'll do our best to bring You more rather than less...

Of BOTH commodities!....So again in 1952, we hope over You the thought will burst - 

That it's both pleasant and profitable in Tulsa, to always THINK - FIRST!

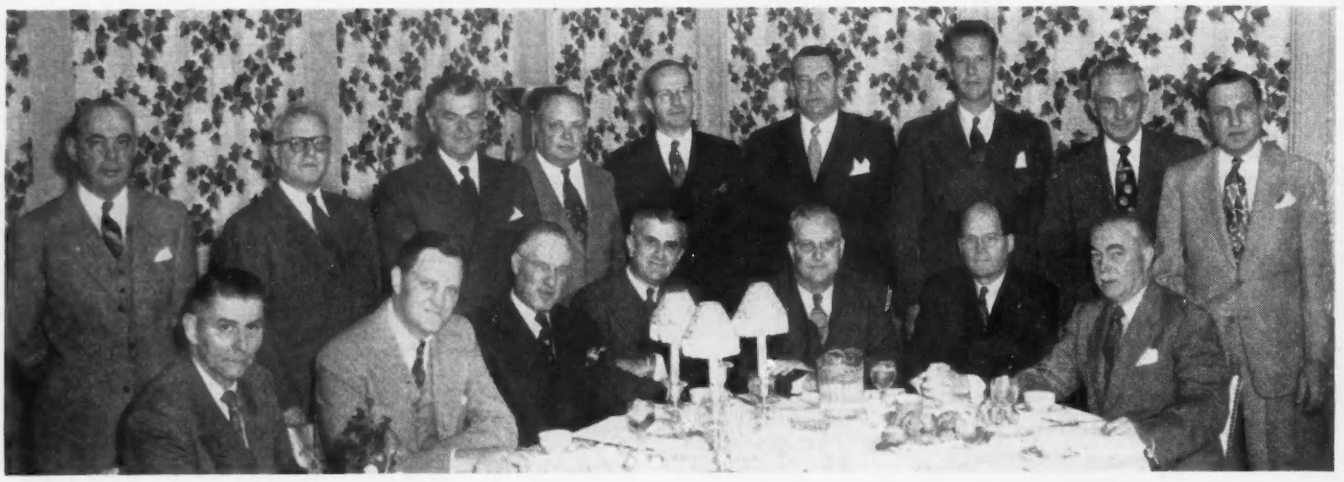
1st of Tulsa



THE FIRST NATIONAL BANK AND TRUST COMPANY OF TULSA

MEMBER FEDERAL DEPOSIT INSURANCE CORP.

When in Tulsa, You are cordially invited to visit our new building. See the FIRST mural interpretation of the famous Oklahoma Runs.



TOP DRESSER OPERATING OFFICIALS are pictured as they met in Chicago to discuss an Executive Training Program. Left to right, standing, are Willard Johnson, president, Magnet Cove Barium Corporation, Houston; Robert H. Owens, president, Roots-Connersville Blower Corporation, Connersville, Ind.; J. H. Rosecky, general manager, Torrance plant, Ideco Division of Dresser Equipment Company, Torrance, Calif.; C. Paul Clark, president, Clark Bros. Company, Olean, N. Y.; Eric Flaschar, president, Stacey Bros. Gas Construction Company, Cincinnati, Ohio; Otto Hammer, president, Security Engineering Company, Inc., Whittier, Calif.; W. O. Cook, general manager, Beaumont plant, Ideco Division, Beaumont, Texas; L. T. Wold, vice president, Kobe Division of Dresser Equipment Company, Huntington Park, Calif.; C. E. Ponkey, vice president, Ideco Division, and general manager, Columbus plant, Columbus, Ohio. Seated are T. L. Moody, director of industrial relations, Dresser Industries, Inc., Dallas; R. P. Brown, director of personnel and organization planning, Dresser Industries, Dallas; A. R. Weis, president, Pacific Pumps, Inc., Huntington Park; H. P. Boncher, general manager, Dresser Manufacturing Division, Bradford, Penn.; R. E. Reimer, vice president, secretary and treasurer, Dresser Industries, Dallas; H. N. Mallon, president, Dresser Industries, Dallas, and J. B. O'Connor, executive vice president, Dresser Industries, Dallas.

Waukesha Organization Announces Changes and Additions to Staff

Promotions for a number of key personnel and the addition of four new salesmen was announced by Waukesha Sales and Service, Inc., Houston.

Walter Buehring, former district manager in the New Iberia, La., area, has been named to the newly created position of service parts manager. H. N. Carter, former branch manager in the Corpus Christi area, will be assistant service parts manager.

J. B. Krenek, former branch manager of the Waukesha Kilgore, Texas, store, has been named district manager at New Iberia. M. D. Russell, former parts manager at Kilgore, has been promoted to branch manager.

Frank Williams, former sales engineer, was promoted to district manager in Houston. G. C. Shows was promoted to branch manager.

New sales engineers include Leon Miller, Pampa, Texas; G. C. Sies, Odessa, Texas; Harry Goss and Bert Coleman, Houston.

Gotkool
water cans
and coolers
GOTKOOL WATER CAN
Made in 1½, 2, 3, 5, 10, 15 and 20 gallon sizes. Push-Button Faucet at slight additional cost.
KEEP PURE DRINKING WATER ALWAYS HANDY
GOTKOOL WATER COOLER
Made in 2, 3, 5, 8, 10, 15 and 20 gallon sizes with Push-Button Faucet.
GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug-fitting, large, removable top, handy non-leaking push-button faucet. GOTT Water Cans for handy field use. Your supply store has them, get one today!
STANDARD OF THE OIL FIELDS
Insist on the Genuine
Gott
GOTKOOL
WATER COOLER
PURE
WATER
H. P. GOTT MFG. CO.
WINFIELD, KANSAS

Black, Sivalls & Bryson Assigns Baze to New Los Angeles Office

Black, Sivalls & Bryson, Inc., has opened an office in Los Angeles, and has appointed Ross Baze West Coast sales manager, with headquarters at the new office at 1274 La Brea Avenue.

Ross Baze

Baze, a graduate of the University of California with a degree in architecture, was assistant sales manager of the Climax Controls division of Climax Industries, Tulsa. When Black, Sivalls & Bryson bought Climax Industries, Baze was named sales manager of its Climax Controls division.

Bill Lacy, sales engineer, will also work in the Los Angeles sales office.

Announcement of the opening of a new office in Wichita Falls, Texas, was also made by BS&B. L. M. Petrie, who will be in charge of the new office, is a graduate of Oklahoma A. & M. College, where he majored in chemical engineering. Petrie is a veteran of 3½ years with the Marine Air Corps in World War II, and held the rank of captain. He was first employed in the BS&B Kansas City Engineering department, and was later transferred to Odessa, Texas, then to Nocona, Texas.

National Supply Advances Furman

Stanley L. Furman, Eastern division credit manager for The National Supply Company, Pittsburgh, has been appointed assistant general credit manager with supervision of credit offices of the company's Eastern and Northwest oil field divisions. He is a veteran of 15 years' service.

OIL CENTER TOOL COMPANY, Houston, has opened this new warehouse store at 2316 Antelope in Corpus Christi. Mike Hunter is Southwest district manager, with headquarters at the new office.

Formation of Canadian Concern Is Announced by Cameron Iron Works

Cameron Iron Works of Canada, Ltd., has been organized by Cameron Iron Works, Inc., Houston, to distribute Cameron products to Canadian oil operators through recognized oil field supply companies operating in Canada.

N. G. Loudoun, sales representative for Cameron in Canada, maintains a business office at 10158 Jasper Avenue, Edmonton, Alberta.

Thornhill-Craver Company Appoints Lewis as Canadian Representative

Delbert D. Lewis of Import Tool Company, Ltd., Edmonton, Alberta, has been appointed Canadian representative for Thornhill-Craver Company of Houston.

Delbert D. Lewis

A native of Texas, Lewis served as drilling superintendent for Standard Oil Company (N. J.) in Venezuela for a number of years and was field superintendent for Newell and Chandler in the Turner Valley field in Alberta.

Lewis' head office is at Edmonton, with warehouses at Calgary and Stettler.

Hoist Company Elects Jim Coffing To Top Sales-Advertising Position

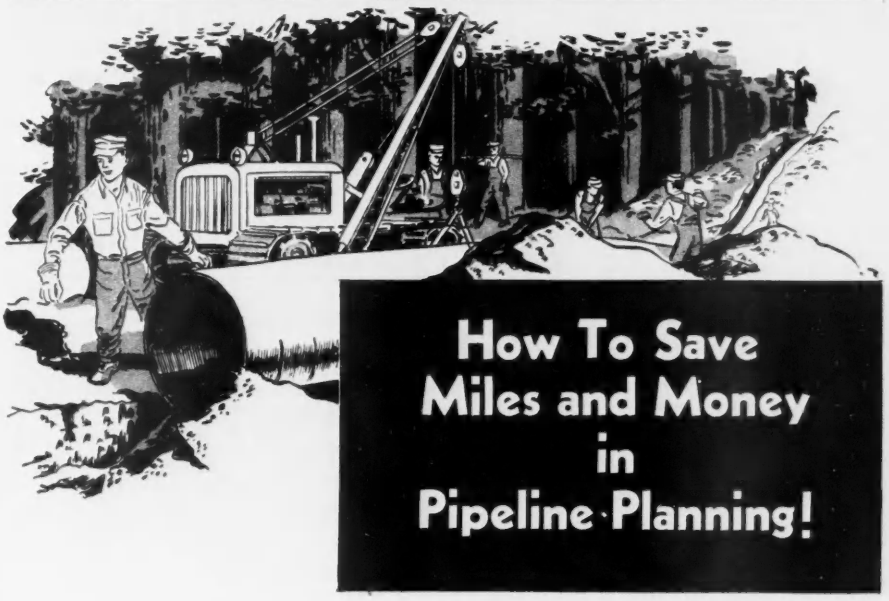
Coffing Hoist Company, Danville, Ill., has elected J. R. (Jim) Coffing vice president in charge of sales, advertising and general office administration.

J. R. Coffing

Coffing first started with the company at the age of 12 as a clean-up boy. He worked his way up through the various departments of production and administration to become general sales manager prior to World War II. Following 2½ years' service in the Army, he resumed his position as general sales manager.

Moore Joins Louisiana Land

Homer G. Moore has joined The Louisiana Land and Exploration Company as chief geologist. A 1941 graduate of the University of Oklahoma, Moore worked in the Geological department of Pan American Production Company as senior geologist in charge of South Louisiana and Mississippi.



Use An Abrams Aerial Survey Because

1. You can, in settled areas, by-pass expensive right-of-ways through cultivated fields, timber stands, orchards and similar items—expensive legal entanglements are avoided.
2. You can, in wild areas, by-pass or cross most advantageously, bogs, swamps and small lakes which are not shown on county maps—avoids expensive probing.
3. You can compute and order swamp and river weights in advance.
4. You can easily check progress reports and compute speed of stringing for each kind of terrain.
5. You can locate and use trails or easy access routes to the job in wild areas.

Abrams surveys do save miles and money—one client recently reported saving 1½ miles of line in just one 12 mile section—a saving that paid for the entire survey many times over.

Write for complete information and a copy of "Pipeline Planning from the Bird's-Eye View."

ABRAMS AERIAL SURVEY
CORPORATION
LANSING 1, MICHIGAN, U.S.A.

WORLD OIL'S Trading Post
CLASSIFIED ADVERTISING

RATES: Regular Classified (undisplayed) set in this size type: 12 cents per word. Minimum charge, $3. Blind box address in our care counts six words. Replies forwarded without charge. **Situation wanted** ads, 6 cents per word. **Display ads**, set in suitably larger type with ruled border, $12 per column inch; situation wanted display ads, $6 per column inch. Ten percent discount for two or more insertions of same copy in consecutive issues. **All classified ads payable in advance. COPY DEADLINE:** 5th of month preceding date of issue. Send copy and checks to: **Trading Post Section, World Oil, P. O. Box 2608, Houston, Texas.**

FOR SALE

■ Well drills, spudders, rotaries, core-drills. **All sizes new and used equipment. Tools, drill pipe, cable, pipe. Fishing tools rented. Everything for well drilling. Pressey & Son, Pueblo, Colorado.**

■ 44 OIL FIELD Cyclone Churn Drill. Has only drilled 4000 ft. since purchased new. Mounted on 3 Ton International Truck; Truck in perfect shape. Good Tires all around. 700 ft. ¾ inch Cable. 400 ft. 7/16 inch Sand Line. Blower and Reverse gear attachment. Price, $5700. Kabele Bros., Platteville, Wisconsin.

USED DIESEL BOATS

4—110′ Ex-Subchasers
1—104′ A.C.R. Boat
1—115′ Steel Tug
1— 45′ Steel Tug
1— 31′ Work Boat
1— 30′ Pusher Tug
1— 75′ C.G.C. Wood Hull

NEW BOATS

1— 45′ . . . 1—55′ Tug
1— 42′ 6″ Tow Boat
1— 30′ Water Taxi
1— 38′ Water Taxi

Equitable Equipment Company, Inc.
410 Camp Street New Orleans, Louisiana

■ NORTH DAKOTA AND SOUTH DAKOTA BASE MAPS. Base Maps of North Dakota and South Dakota: County outline, township and range, location of all wells, and operators names with total depths. Oil and Gas Fields. 1″—8 miles. Priced $5.00 each. COUNTY MAPS: fee ownership and lease with expiration dates. Scale 1″—4000 ft. Northwest Mapping Co. 117½ Fourth St. Bismarck, North Dakota.

■ TWO 150 horsepower F and T boilers located at Eunice, New Mexico. Makin Drilling Co., Box 131, Hobbs, New Mexico.

FOR SALE
COMPLETE ROTARY DRILLING RIG (POWER)

98′ Moore Jackknife Derrick Complete; Cardweil R. L. Double Drum Draw Works W/ W.A.K. Motor; 6 x 12 P. OIL Well Mud Pump W/ G.K. 145 Wax. Motor; Emsco Oil Bath Rotary; Traveling Block 4 Shieve; Swivel 6″ Bethlehem Like New; Kelly 4½″ Bethlehem Like New; Rotary Hose 4″ Neoprene Like New; Drill Pipe Hughs Modified 4½″ 5100′; Reed Core Barrel; Shale Shaker; 2 Drill Collars Union Tool 6¾″ x 25′; Cameron Blowout Preventer Fluid Operated; Master Gate Valve Fluid Operated; 2 Pr. Wilson Tongs B. J.; Air Compressor; 2 Water Pumps; 4000′ 2″ Line Pipe; Light Plant Unit Inhoused; Mud House; Steele Tool House; Dandy Steele Bunk House 32′; Steele Water Storage Tank 140 Bbl.; 30′ Connection Rack (Junk Box); 4½″ Elevators; 2″ Elevator Tubing; Portable Steele Pipe Racks & Ramp; Run Ways, Ladders, Pipe Tongs, Wrenches, Small Tools, Etc.; D.60 International Truck Oil Field Body; Winch & Gin Poles; Chevy Truck 4 x 4 Oil Field Body Winch & Gin Poles. E. B. Clark, Petroleum Bldg., Phone 66 Day or Nite, Alice, Texas.

HELP WANTED

COMPTROLLER EXECUTIVE

Position open with large independent oil producer in Houston area — only those with extensive experience need apply. Excellent opportunity. Address: Box 25-W, c/o WORLD OIL, Houston, Texas.

BUSINESS OPPORTUNITIES

■ **WE WILL BUY Producing Oil Royalties. Send Particulars. Standard Security Co., 111 Broadway, New York 6, New York.**

■ British Engineering Company with considerable works facilities doing large business in vessels, pipes and fittings with oil, chemical and steam industries, would be interested in a manufacturing or selling association with American firm. Box No. 34-W, c/o WORLD OIL, Houston, Texas.

SITUATION WANTED

■ Geophysicist, Geologist, Engineer desires change after settlement of present business. Box 36-W, WORLD OIL, Houston, Texas.

■ Communication, Age 37. Now senior engineer with large railroad. Extensive experience with microwaves, VHF radio, wire lines, carrier, and teletype. Capable of handling engineering or administration of any size system. Reply Box 35-W, c/o WORLD OIL, Houston, Texas.

ATTENTION

Practicing Philanthropists, Struggling Oil producers, Service Companies, etc. I am a lazy lout who has spent 30 of his 42 years in the oil fields of Texas and must have $7500.00 per year to maintain my family in the style to which they have accustomed themselves. I feel I am worth at least $10,000.00 because I have been EARNING quite a bit more.

If you feel your development is hampered by such things as the restrictive limitations of 24-hour days and have wished for a few 40-hour days so you could catch up, then possibly you could use the help of a dull fellow whose sense of responsibility to a job is such that he feels a days work should be done before he knocks off to head for the goody-goody joint.

I do not wish to make any false starts so if you would like us to get together for a frank discussion in which neither would hand the other any stuff, you may contact me through this publication. Address Box 33-W c/o WORLD OIL, P. O. Box 2608, Houston, Texas.

EQUIPMENT and SERVICE SUPPLIERS' NOTES

W. K. Waters

Harry A. Wyckoff

Otis Announces Assignments to Oklahoma City Supervisory Staff

Harry A. Wyckoff, a veteran of 15 years' service with Otis Pressure Control, Inc., has been appointed superintendent of Otis' Oklahoma City division. He will be assisted by W. K. (Jug) Waters, formerly in the Odessa, Texas, office.

Wyckoff joined Otis in 1936, working out of Ada, Okla. He has supervised unusual pressure control jobs from the Gulf Coast area to the Arctic circle, and from California to the Eastern Seaboard.

The new assistant division superintendent, Waters, worked in the Dallas manufacturing plant before going to Odessa. He has a degree in petroleum engineering from Southern Methodist University.

National Supply Advances Bullied To Accountant for Canadian Division

The National Supply Company, Pittsburgh, has promoted Russell H. Bullied to division accountant for its Canadian division. His headquarters are at Calgary, Alberta, in the office recently opened to handle all Canadian sales accounting functions and thereby facilitate customer transactions.

Employed in December, 1950, as a clerk in the credit department at Calgary, Bullied was transferred to the position of pricer in January, 1951, a position he held until his present promotion.

SITUATION WANTED

Drilling contractor operating in West Texas and New Mexico desires to contact small or medium-sized independent oil company who needs an operating manager. Personal interview desired. Twenty years experience in all phases of the oil industry. Address replies to Box 94-W, WORLD OIL, Houston 1, Texas.

WANTED TO BUY

■ WANTED—Suitable unitized portable drilling rig; 3,000 to 3,500 foot capacity; complete with 3,500 feet of 3½″ EUE drill pipe; min. 7½ x 12 pump; mast, etc. Send full details and quote price F.O.B. loaded cars, to American Northland Oil Company, 127 Montgomery St., San Francisco, California.

FOR RENT

■ For Rent: Warehouse and storage yard. Lafayette, La., on O.S.T. 90 & railroad. 200 x 700 enclosed with Hurricane fence. Hard surfaced driveways. Mike Donlon, Realtor, Lafayette, La.

DECALS

TRUCK LETTERING AND TRADEMARK decals made for your trucks. Easy to apply, uniform, distinctive, economical for small or large needs. Write for Catalog. Mathews Company, 827 S. Harvey, Oak Park, Ill.

New Books, Maps and Movies

THE STRUCTURAL MAP OF TEXAS, Third Edition, by E. H. Sellards and Leo Hendricks, The University of Texas, Bureau of Economic Geology, University Station, Box B, Austin 12, Texas.

This map, originally issued November, 1946, has been reprinted. The Bureau of Economic Geology also has on file and available in photographic copies the following manuscript geologic maps:

Tascotal Mesa Quadrangle, Brewster and Presidio Counties, by Ralph L. Erickson.

Agua Fria Quadrangle, Brewster County, by C. Gardley Moon.

Hood Springs Quadrangle, Brewster County, by Roy W. Graves.

Christmas and Rosillos Mountains, Southern Brewster County, by Richard R. Bloomer.

SUMMARY OF SECONDARY RECOVERY OPERATIONS IN LOUISIANA IN 1951, Interstate Oil Compact Commission, Box 3127, State Capitol, Oklahoma City 5. Free.

A report on a joint project of the Louisiana State Secondary Recovery Advisory Committee and the IOCC Secondary Recovery Division, this 40-page pamphlet includes a paper entitled "Secondary Recovery Projects in Louisiana," by Edward A. Alberes, Louisiana Department of Conservation. There are also tabulated data of secondary recovery operations on 64 fields, as well as performance history graphs of 11 fields.

SOCORRO COUNTY, NEW MEXICO, MAP, by R. H. Wilpolt and A. A. Wanek, State Bureau of Mines, New Mexico Institute of Mining and Technology, Socorro, N. M.; or Distribution Section, U. S. Geological Survey, Denver Federal Center, Denver, Colo. 80 cents.

A new geologic map covering a 1500-square mile region from Socorro and San Antonio east to Chupadera Mesa, Socorro County, N. M., measures 41 x 54 inches and is printed on two sheets in three colors. In addition to providing information about Socorro County, the map may be helpful to petroleum geologists and geophysicists in exploring the Jornado del Muerto, immediately to the south of the subject area, where bedrock is almost entirely concealed. The map includes a graphic presentation of geological structure, seven geologic cross sections, two index maps, and a brief description of the geology and oil and gas possibilities of the area.

DAN PAYNE'S LOUISIANA-MISSISSIPPI OIL & GAS DIRECTORY. Daniel O. Payne, 1031 National Bank of Commerce Bldg., New Orleans 12. $25.

The book contains a listing of more than 40,000 firms and personnel in the Louisiana-Mississippi area, with all listings cross-referenced under three sections: Towns and Cities, Alphabetical and Classified. There is also a section showing current locations of both active drilling rigs and rigs stacked. A quarterly supplement to the directory will record changes of personnel, new companies, opening of branches and similar events which occur after the complete biennial directory is published.

OIL AND GAS FEDERAL INCOME TAXATION, Second Edition, by Kenneth G. Miller. Commerce Clearing House, Inc., Chicago and New York. $7.50.

Up-to-date law, regulations, rulings and decisions of federal income taxation as they apply to oil and gas production in this 284-page volume. Discussed are depletion, time for depletion deduction, economic interest, interests in oil and gas in place, leasing problems, intangible drilling and development costs, special problems affecting drilling contractors, and associations taxable as corporations.

WATER TREATMENT FOR INDUSTRIAL AND OTHER USES, by Eskel Nordell. Reinhold Publishing Company, 330 West 42nd Street, New York City. $10.

This reference work on conditioning water supplies for industrial and domestic uses deals with their impurities and the methods of treatment to fit them for a variety of uses. Both basic principles and solutions to specific problems are discussed by the author, who is administrator of the analytical laboratories, Research and Pilot Plant divisions, of The Permutit Company.

RED DEVIL

"DIA-HARD" LINERS

For high pressure abrasive service

Forged in one piece from highest quality alloy steel. The deep HIGH-CARBON wear resistant case of maximum hardness and uniformity is obtainable only by our SPECIAL "DIA-HARD" PROCESS, greatly excelling all other known methods for longer life liners. The bore is PRECISION HONED, and ACCURATE OUTSIDE DIMENSIONS insure a perfect working fit with liner packing assembly and pump cylinder for positive leakproof sealing. Write for Catalog No. P-120.

TELL-TALE LINER PACKING ASSEMBLIES

Gives warning before damage

Tell-Tale Liner Packing Assembly consists of two "DIA-TEX" oil and heat resistant sealing rings separated by a precision made steel, corrosion-resistant Jantern ring. Internal leakage is detected instantly in slush pumps through "tell-tale holes" before costly fluid cuts occur to cylinder walls. There is either a Tell-Tale Liner Packing Assembly or a "DIA-TEX" Sealing Ring available for all makes of slush pumps. Write for Catalog No. P-121.

LINER PULLERS

Save valuable time and labor

The Red Devil Liner Puller is a strong, heavy duty, dependable tool capable of pulling the most obstinate liner. Its operation is simple. There are no pins, connecting links or other small parts to bend, shear, break or become lost.

The "Universal Type" Puller (as illustrated) is designed for slush pumps. The "Expanding Grip Type" is designed for pulling thin wall-driven tube type liners, as used in small pumps. Write for Catalog No. P-122.

See Composite Catalog . . .
For more detailed information on Red Devil Products, see the Composite Catalog or write for special price catalogs noted above. Red Devil products are available through your supply store.

OIL WELL MANUFACTURING CORP.
6008 S. Alameda St., Los Angeles 1, Calif.

FOR SPEED WITH SAFETY ON ROD JOBS

use

O'BANNON HOOKS AND ELEVATORS

You can depend on them for fast, safe operation; both are carefully engineered and are made of alloy steel heat treated for maximum strength and toughness.

ROD HOOKS—

Fast because they are so balanced that they are easy to guide onto the load.

Safe because of their strength and because the latch stays locked automatically until released by the operator. Hook swivels freely on a large ball bearing fully enclosed to keep out dirt.

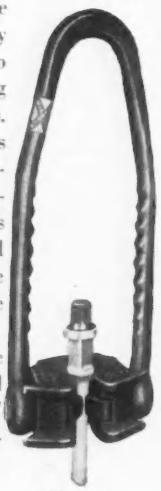
Regular type Rod Hook without guard

ELEVATORS—

Speedy because latches operate easily and bail is flared to allow quick handling of transfer elevators.

Safety factor is typified by latch arrangement which includes two latches either of which will keep the rod in place if the other is made inoperative.

Sizes are available for 5/8", 3/4", 7/8" and 1" rods and for 3/4" and 1" plain and upset tubing.



Elevator

API RATED CAPACITY
(1/4 of breaking load)

HOOKS	
Regular Type	33,000 lbs.
Spring Type	34,000 lbs.
ELEVATORS	
Regular	31,000 lbs.
Milelift	38,000 lbs.

Make your rod jobs faster and safer by using O'Bannon Hooks and Elevators.

Sold By Supply Stores

WALTER O'BANNON CO.
TULSA 1, OKLAHOMA

SQUEAKS from the BULLWHEEL

Hidden Meanings

Virgin Pine: A tree that just hasn't been axed yet.

Alcatraz: The pen with the lifetime guarantee.

Heaven: 1952 wages, 1926 dividends, 1932 prices, 1910 taxes.

Out on a Limb

Mrs.: "Strange how few of our youthful dreams come true."

Mr.: "Oh, I don't know about that. When I was small I used to dream about wearing long pants. And now prices are so high I have to wear pants longer than anyone else on earth."

Fair Heired Boys

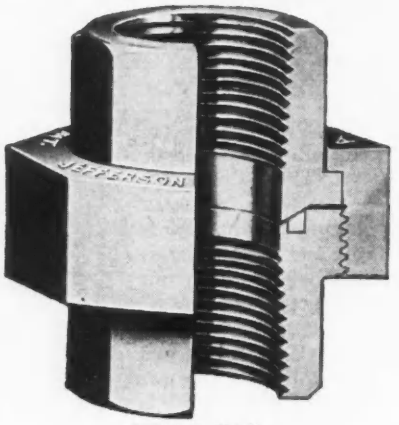
The wealthy old man had passed on. His estate was left jointly to his two sons. The two agreed to accept the decision of an old friend of the family as to how the property should be halved.

"I think the oldest son should divide the estate as he sees fit," decided the friend. At this the older son beamed, but the younger's face grew longer.

"Then," continued the arbitrator, "the youngest son will take whichever half he prefers."

"mmmm . . . No sense in worrying what part of the industry he'll go in for—wonder if there's much money in water-flooding?"

Jefferson Malleable Unions



STYLE "A"

JEFFERSON Style "A" Unions and Style "A" Union Fittings can be furnished with Brass-to-Iron, and Iron-to-Iron Seats.

HYDRAULIC PRESSURE RATING

Sizes	*Test Pres.*	*OWG*	*SWP*
1/8" thru 2"	4000#	1500#	500#
2 1/2"	3000#	1200#	300#
3" and 4"	2000#	800#	300#

Our "Iron-to-Iron seat" unions are highly recommended and especially desirable where sulphur content of oil is high; also for chemical services where acid-bearing liquids or gases require the use of iron fittings. AIR FURNACE IRON, having a much denser and finer grain structure, gives a dependable and positive seating surface—ASTM-4733-Grade 35018-53000-lb. M.T.

Obtainable through your jobber

Jefferson Union Company, Inc.

691 West 26th St.,
New York 1, New York

71 Gooding St., Lockport, New York

31 Fletcher Ave., Lexington 73, Mass.